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Mechanization, Management and the Competitive Position of Agriculture[1]

By M. L. Wilson[2]

I DESIRE to single out but three of the many important forces which are producing new and difficult problems in farming:

1. Mechanization — the impact of the machine age on agriculture.
2. Scientific production technology, or the effect of scientific development on farm practices.
3. Scientific farm management which results from operating under a money economy and the reaction of the business age.

If we characterize the agricultural era prior and during the World War as one of expansion, land hunger, and land speculation, by the same token we will have to characterize the last fifteen years in some other manner. There is a good deal of evidence that mechanization, scientific technology, and scientific farm management set in motion new forces which would have caused great readjustments in farming had there been no agricultural depression. The changes that have taken place so far have operated even though agriculture has been in a relatively unfavorable situation.

These forces have caused and are causing changes in the attitudes of farmers toward farming. Farming is still a mode of life but a different mode than it was twenty-five years ago during the time of the kerosene lamp, the horse and buggy, and the weekly newspaper. The automobile and the desire for consumers' goods of one kind or another have pulled hard on the farmer's net income. Who knows but that the age-old desire for the ownership of land in the minds of many farm people is being shifted inperceptibly to a desire for automobiles, entertainment, enjoyment,—in fact, for immediate consumption goods. In other words, are the new wants created by the machine age causing farmers to value their living standards higher than land and thus to spend rather than save? If this be true, it is of great significance.

Whether it is for good or bad, during the past fifteen years a great shift from self-contained farms to commercialism in agriculture has taken place in those areas of the United States adapted to commercial agriculture. Many farmers now buy the transportation which was formerly raised on their farms. The farmer buys food, clothing, and entertainment that was formerly produced in his own household. He lives in a community with improved roads and good schools. This commercialism requires larger money income. While the present terrific economic depression has temporarily tended to obscure some of this farm commercialism, yet no one doubts but that it will return as soon as there is recovery in prices and prosperity. To meet these new forces, American farmers must transfer the superb intelligence which they exhibited during the pioneer self-sufficing stage into new attitudes of economic understanding, education and cooperative activity.

These new conditions tend to place the productive capacities of land in relatively different positions than they occupied in the past. While little change is anticipated in the productive capacity of the land itself, the human and economic relationships may be expected to be in a state of flux if we are to continue in the path of progress.

MECHANIZATION IN AGRICULTURE

"Mechanization" is indeed a poor word to characterize what I have in mind. Rather it is the application of engineering to agriculture. The agricultural engineer cares little for tradition and has as his ultimate objective efficient production and low-cost output. While unhampered by custom, he seeks ratios of efficiency through control of natural and mechanical forces. The engineering point of view is comparatively new in agriculture. It has made tremendous strides in the last fifteen years. We have no reason to doubt that it will have the same importance in agricultural production in the future as it has in other phases of industry. Neither is there any justification for thinking that it has reached its ultimate goal; rather the best engineering judgment is that it has a great many things in store which will continue to modify agricultural practice, the lives of farm people, and the business organization of farms in the future.

Internal-combustion engines have caused and will continue to cause great readjustments in farm organization and operations. It is roughly estimated that in 1920 there were 250,000 tractors on the farms in the United States. In five years these had doubled and reached the 500,000 mark, and, in round numbers, in 1930 had grown to 1,000,000.

Dr. O. E. Baker, of the U.S.D.A. Bureau of Agricultural Economics, estimates that the elimination of 9,000,000 horses and mules from the farms and cities of the United States by internal-combustion engines has released approximately 25,000,000 acres of land scattered over the United States from producing feed with which to supply these horses and mules and has resulted in a 13 per cent increase in land available for other crops. While

It is quite probable that agricultural production in the future will require a unit or given amount of land to go with a unit of machinery

[1]An address before the Land Utilization Conference called by the Secretary of Agriculture, at Chicago, in November 1931.

[2]Professor and head of the department of agricultural economics, Montana State College.

there is much to be said in favor of the use of horses and mules, especially in times of low feed cost, nevertheless, the tendency for the replacement of horses by tractors appears inevitable for several years to come. Less that half enough colts are being raised to replace the horses and mules that die or become incapacitated yearly. The 1931 Outlook of the Bureau of Agricultural Economics says, "The total number of all horses and mules which was 25,000,000 in 1920 will be reduced to 10,000,000 by 1940, providing births continue at the present rate." If motorization is to continue, it will tend to concentrate certain types of production on level lands adapted to tractor operation, and a vast reorganization of farms and farm operations all over the United States will be inevitable.

In general, we may say that motorization and mechanical development have produced new levels and margins of competition in the major crops, such as wheat, corn, and cotton. The results of this machinery change are well known. Cost of production figures of agricultural commodities are always difficult and complicated because of the many intangibles in farming. It is, therefore, difficult to use any set of cost figures as a complete basis for comparison.

But during the last decade the engineering developments in connection with power farming equipment and farm organization have greatly reduced labor requirements and unit costs. In the great plains of the United States and Canada a unit of land and a unit of machinery, consisting of tractor, combined harvester-thresher, tractor drill, tillage implements and truck, produce wheat at new levels of low cost and high efficiency. The Mississippi Delta Experiment Station, at Stoneville, Mississippi, gives the following variations in costs between hand tools and mechanical equipment in producing cotton (labor, power, and machinery cost per acre):

One mule, half-row equipment	$14.20
Two mule, one-row equipment	10.78
Tractor, two-row equipment	6.78
Tractor, four-row equipment	5.20

Changes in harvesting and processing cotton are under way. Likewise the general-purpose tractor with its complemental unit of corn equipment — three and four row planters, cultivators, two-row pickers, etc. — tend to produce new competitive levels and to require reorganized farms.

Truck transportation and good roads are producing a revolution as well. The U. S. Department of Agriculture states "Motor trucks are hauling 15 per cent of the total shipments of fresh fruits and vegetables which are transported twenty miles or more to markets. They are now delivering 27.3 per cent of the total livestock receipts. During 1930, 17,000,000 head of cattle, hogs and sheep went to market in trucks. This was an increase of 17 per cent over 1929 and the equivalent of 275,000 single-deck freight cars."

These changes resulting from agricultural engineering are by no means confined to cotton, wheat, and corn. They are to be found all over the agricultural field. As an example, Dr. H. C. Gardiner, of Montana, who operates an alfalfa-sheep ranch, upon which the problem of making alfalfa hay and feeding it during the winter to ewes and lambs has been greatly modified as the result of the engineering approach. This farm has developed what might be called a new hay making and feeding system. The hay is chopped into small lengths in the field, stored and automatically fed through specially constructed self-feeders. When so fed, the manure is free from coarse, strawy material and can be dumped into irrigation ditches and thus distributed over the land by means of the irrigation water. This new system has not only increased as a result the efficiencies in hay making, the handling from the field to the feedlot, feeding, distribution of the manure, etc., but the costs have been reduced 40 per cent.

Unless agriculture becomes static and dormant we may anticipate changes due to the introduction of the engineering aspect of agriculture with greater force in the future than in the past. It is a safe assumption that industrial development in other fields will have an important bearing on the evolution just described. No one as yet knows what may be the effect of the new light steel alloys which are being developed. The specific gravity of steel is about 7.70. New alloys which are one-fourth as heavy and have the properties of steel, are being developed. In agriculture, machinery and equipment must of necessity be transported over the land. If these new alloys are adaptable to the manufacture of agricultural equipment, then only experimentation and the engineers can forecast what the effect will be of lightening the weight of equipment by 75 per cent.

New developments are taking place in track type tractors and in fitting flexible rubber fabric tires to wheel tractors so as to give greater traction and relatively slight soil packing.

No one knows what industrial chemistry has in store for agriculture. It is within the limits of chemical possibility that fuels and cellulose products may become important by-products, or, for that matter, main products of commercial agriculture.

It is highly probable that agricultural engineering and technology will develop new and more efficient low-cost processes and tools having to do with the control of weeds, soil tillage, planting and harvesting of crops, in fact, with all operations which are subject to mechanical manipulation.

During the past 150 years, the application of engineering to industry or the machine age, if you please, has produced great changes and, by and large, great advances in the standards of living. This progress has been at a price, and that price has often been temporary unemployment and human misery. But the machine age has done much for agriculture. In the past, these shocks have been absorbed by movement to free lands and expanding European markets. If we are to look forward, however, to an increasing influence of the machine age on agriculture, and if we are to learn anything from history, we must be prepared for difficult readjustments and our research agencies must be in a position to supply the type of facts whereby farmers can make these adjustments at the least social cost. While I shall point out later that these changes do not necessarily mean a change from family farming, they certainly do mean realignments in the use of land, managerial abilities and capacities of farmers and emphasize new comparative advantages.

SCIENTIFIC TECHNOLOGY

Scientific research in agriculture is continually increasing the complexity and skill required in farming practices. The net results of research and experimentation relative to the crops, soils, livestock, and, in fact, all phases of agriculture tend to replace custom and habit with complex ways of doing things requiring knowledge and skill and a high level of education and intelligence. Many examples of these changed practices which have taken place in the last ten years may be cited. They are to be found in every field of agriculture.

Under the best of conditions, there is a lag in the acceptance of new technology by farmers. Recently a survey was made by a corn belt experiment station of a group of townships in which extensive extension work has been carried on for seven years in connection with hog sanitation and feeding. At the end of a seven-year period of intensive extension and demonstration work it was found that only 37.6 per cent of the farmers raising hogs were practicing some phase of the sanitation system, only about 1.5 per cent were practicing the recommended system of feeding and sanitation in its entirety, and 18 per cent had discontinued raising hogs during the seven years because of disease, parasitism, small litters, no profit, etc.

I could go on at endless length pointing out illustrations of just this type, indicating under normal conditions the widening of the competitive advantage of some farmers and some areas against others. If our agricultural research institutions are to be maintained and the flow of scientific knowledge to be as great in the future as in the past, we

may anticipate at least as great changes from this source in the future as in the past.

SCIENTIFIC FARM MANAGEMENT

Each change in farming that takes place as a result of the application of engineering, mechanization, or technological science results in new economic problems for the farmers. They require readjustments in farm organization and operation, and present problems of management. The tendency also is to increase the capital required for farms but not necessarily a greater investment per acre. It is quite probable that the machinery used in agricultural production in the future will be of such a nature that it will require a unit or given amount of land to go with a unit of machinery.

Scientific management requires budgetary methods, accounting control, and farming plans in keeping with production practice, standards of accomplishment, and future economic conditions which are to be ascertained from the Outlook Service of the U. S. Department of Agriculture and the colleges.

There will no doubt be a tendency in many cases for farms to be adjusted so as to give the most economic use of mechanical equipment and individual managerial ability. To what extent will the foreclosure of farms and loss of operator ownership, which is taking place during the present depression, affect this movement for the consolidation of holdings after agriculture starts on the upgrade? Is there a possibility that agricultural finance in the future will have a tendency to expand the credit of the money-making type of farm and contract the credit of the farm which is unable to make this kind of adjustment? If such is the case, this adjustment in the size of farms may take place at a rapid rate.

There has been springing up during the past few years throughout the United States managerial assistance. These range all the way from a cooperative farm management service such as the county farm management associations in Illinois which cooperate with the farm management division of the college of agriculture, and which has a system of accounting and advise as to the reorganization of farms, to systems where numerous farms are operated under the general supervision of a specialized manager. Without doubt the present depression, unless prices rise shortly, will greatly reduce the number of owner-operated farms and increase the number of tenants. Will the new owners of these lands acquired through foreclosure have a tendency to develop some system of supervision? Who knows but that possibly we are on the verge of some new type of cooperative managerial agricultural organization. I am informed by Mr. D. Howard Doane, president of the American Society of Farm Managers, that this type of service is greatly on the increase.

By way of summary, American agriculture is not only in the depths of depression, but in the grips of an intense competitive struggle, both internally and internationally. Looking beyond the immediate depression, we see the following:

1. An increasing differential between the better grades of land and the poorer grades of land, and constant pressure on the high cost acres. There is no reason for gloom as far as the low cost regions are concerned.

2. A well-managed efficient agriculture, producing at reasonable cost, with adapted farm equipment and livestock in the low cost areas. Engineering and technology changes will make the obsolete farm more obsolete for commercial production as time goes on.

3. In the international competitive field we may look for the same adjustments taking place, providing nationalistic aims, tariffs, national self-sufficiency, etc., to not arbitrarily curtail or prevent international trade. If they do not, I am sure with our efficiency due to mechanization, scientific production practices, and management that we can successfully compete as far as our low cost regions are concerned.

4. The adjustments in the offing require all the foresight and planning that we can muster up — both land policies and utilization for the long-time period and adjustments in individual farm organization and management for the short-time period.

Better Trained Men Wanted[1]

SCIENCE has reduced drudgery, created new jobs in new industries, and put a premium upon training. Much of the hard work is now done by portable equipment powered by small electrical motors or internal-combustion engines. Electro-magnets have been devised to carry great loads, and compressed air is a convenient method for transporting power to distant tools. Even much of our coal mining is done by power-driven machinery. Glass blowing is no longer the fatiguing art it once was, for air under pressure through clever machines now replaces air expelled from the lungs of the operator.

New industries have been built upon scientific foundations, and long established industries have been improved, requiring men of greater skill. Among the newer industries are motion pictures, automobiles, and all that goes with them, including not only their servicing and maintenance but also the production of their materials, their fuels and their many parts. Radio, domestic oil burners, mechanical household refrigerators, and numbers of devices which have brought small motors into house work may be included. Development of the chemical industry in the United States has likewise demanded its thousands of employees. Dye manufacture, anti-knock compounds for gasoline, new medicinals and pharmaceuticals — the list is too long to be quoted.

Adoption of intricate machinery has been delayed more because of the absence of men sufficiently well trained than the lack of such mechanical equipment. There are always opportunities to make improvements, but these opportunities are available only to men sufficiently well trained.

With the advent of increased numbers of better trained technical men, the call is more insistent for a like kind in all posts. The trained superintendent gets on better with an equally trained purchasing agent, and he in turn can be approached to better advantage by the trained salesman. The engineer finds a congenial place not only in designing and manufacturing but in advertising, in selling, in purchasing, in "trouble shooting."

The tendency is definitely to prefer such men, thus increasing the distance between the really skilled and those who can do only a type of work for which it has not been profitable to devise some sort of machine. There is the demand and the opportunity for the better trained man. It is he who must distinguish between the essentials and the nonessentials and learn the significance of each. It is the trained man who notes the small details that are so important and who applies what has been learned elsewhere to his own problem. A knowledge of sources of information is also a distinguishing characteristic of the trained man of the day.

There will continue to be a demand for those who can apply the methods of the statistician, the mathematician, and the psychologist. The knowledge which characterizes this age of pure and applied science constitutes a reservoir upon which the trained man may draw almost without limit, but such a reservoir is valueless to the one who has not been trained in its use.

[1]H. E. Howe, in "Research Narratives," Vol. 11, No. 13.

Individual Service in House Planning[1]

By Walter G. Ward[2]

THE perpetual problem of individual service in house planning does not seem to approach any comprehensive solution. Families must have shelter, and if the much-to-be-desired high standard of living is to be attained, the need for outside assistance in the planning of homes will become greater rather than less. This demand for individual service in house planning results from the very legitimate desire to show individuality in the home, and also to meet the local conditions, such as topography, climate, and adapting the new structure to harmonize with its surroundings.

For the family financially able to build the more expensive homes, the answer to the problem lies in employing a competent architect, to study, plan and supervise the construction. Arbitrary cost limits are sometimes suggested such as $5000.00, $8000.00 or $10,000.00, beyond which an architect should invariably be employed.

Opinions may very properly differ on where this limit should be which will permit the architect to realize a reasonable profit on his services and yet not be prohibitive to the small home builder. Regardless of what figure might be agreed upon by any responsible group, there will be thousands of homes erected in every state below that figure. In addition there will be other thousands who will not employ a regular practicing architect for various reasons. This is particularly true of the farm house, in which this Society is primarily interested.

With all due respect to the architectural profession, of which I consider myself a member, their work for the farmers whom I have contacted has too often proven disappointing. In many cases the homes are typical of those planned for urban use, without an apparent understanding of the farm families' needs. As an example, I was requested recently by a farmer friend to look over a plan submitted by a practicing architect for their proposed new home. The exterior design was pleasing and well adapted to the surroundings. Much of the plan appeared satisfactory, but not all. The kitchen was approximately sixteen feet square, poorly lighted and about as inconveniently arranged as any I have ever seen. The stairs also were poorly located for convenient use by the members of the farm family.

Since small residence work offers much less opportunity for profit than large structures, the former may quite naturally receive less careful study.

A few years ago I was asked to visit a farm to determine, if possible, the cause of failure of a septic tank to handle the sewage. I found a nice new home costing about $12,000 built from an architect's plan and I believe it was creditably designed. The architect also prepared plans for the sewage disposal system, which was proving troublesome. The farmer had found it necessary to pump out the septic tank every few days, in order that the family could use the plumbing fixtures in the house. Investigation showed a septic tank had been constructed about six feet underground and with a capacity several times greater than the most liberal recommendations for size. For the disposal of the effluent, fifteen lineal feet of six-inch drain tile had been provided.

Perhaps these are exceptional instances, and I wish I could believe that they are. I would be happy to see the architects' individual services considered so essential in the planning of farm homes that few would try to get along without them. If the practicing architect is to secure and retain this field, it would be absolutely necessary for him to study the farmers' problems just as thoroughly as he does the problems involved in more monumental structures. Instead of belittling or ignoring this field in our architectural courses in the colleges, it should be given more attention, or the claim to the field in practice abandoned, perhaps to the agricultural engineers, who at least appreciate the importance of the problem.

The development of certain standards for farm houses will simplify the preparation and should reduce the cost of individual plans for farm houses, regardless of who provides this service. In fact, I believe the final solution of this problem will hinge largely on that idea. It is doubtful if the idea of standardization should extend to the exterior design, although this thought does not seem as horrible to me now as formerly.

How many of us today could be driving an automobile if we insisted on expressing our individuality in custom-made cars. After all, there may be fully as much personal individuality expressed in the selection of the automobile as in the house, which may shelter many families following the one for whom it is originally built. If a certain degree of standardization even of farm house exteriors can make it possible for farm families to enjoy more comfortable, more convenient and more sanitary conditions, at lower cost, is it not worthy of consideration. I believe we have all seen numerous instances of where a married couple have spent practically their entire life together trying to accumulate enough to build and pay for a comfortable modern house. Perhaps that is an ample goal, but I do not believe it is. Should it not be possible, with anything like normal economic conditions, for an average family practicing thrift and industry to acquire a comfortable home in a reasonable period of years, say, ten years? If standardization will help to make this possible, as I believe it will, should we not give more attention to it?

In my extension work, I naturally receive many requests for assistance in planning farm homes, as is doubtless true of all the other structures men. There is perhaps little justification for furnishing this personal service at state expense, but we find it extremely difficult to avoid doing some of this. We endeavor to limit this service to homes which will serve later for demonstration purposes, but we must admit not all have been formally put to that use. Where assistance has been given with individual homes, small incomplete sketches have been prepared to show arrangement of floor plans, perhaps two elevations showing the design of the exterior and a framing section showing the principal framing members. But little detail is shown, and far too little information furnished on which to base competitive bids. In fact, when the owner desires to let a contract for the job, he is advised to secure complete plans and specifications from a practicing architect. A good many of the homes have been built with only the small sketches as guides, employing an experienced builder, usually by the day, to handle the work. In most cases this seems to work out quite satisfactorily, and perhaps offers a suggestion for a possible class of service not at present offered commercially. With standardized details prepared in a manner to be easily duplicated, a small scale sketch would furnish much more information than the motley array of crude sketches, magazine illustrations and verbal instructions so commonly depended on to convey the owner's wishes to the builder. Perhaps this sounds like a lowering of standards in preparing building plans. Doubtless it is from one viewpoint. However, is it not a greater accomplishment to secure marked improvement perhaps in fifty homes, with incomplete plans, than to persuade two or three to secure complete architectural service, while the remainder build with little guidance?

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[1]Paper presented at the Structures Division session of the 25th annual meeting of the American Society of Agricultural Engineers, at Ames, Iowa, June, 1931.

[2]Extension architect, Kansas State College. Mem. A.S.A.E.

The Mechanical Manipulation of Soil As It Affects Structure[1]

By John A. Slipher[2]

MORE than a century ago Jethro Tull, an English farmer, made the gross assumption that tillage improved soil productiveness by reason of its breaking the individual soil particles into smaller fractions. Today it is realized, or rather beginning to be realized, that a more adequate concept is necessary to meet the tillage problem. Very little has soil mechanics dictated design of soil-working tools. Most certainly soil manipulation has been looked upon by the technologist and the farmer as being largely empirical.

The modern approach to the problem of soil manipulation is biologic and dynamic. First of all, it must take account of the biologic objective; what the plant requires of the soil physically. Secondly, the new, broader concept must deal with the dynamic processes operative within the soil body and how these are activated by tillage manipulation. Thirdly, it must recognize that the biologic objective is different for different crops, and that each soil type possesses a physical mechanism peculiar to it alone.

THE MECHANISM OF SOIL STRUCTURE

By manipulating the soil we seek to modify its structure. In any soil, structure is controlled and determined by a definite and delicate mechanism. This mechanism is the granulation process. Tillage is merely the motive force setting this mechanism in operation.

Granule is the Unit in Structure. The process of structure-making yields aggregates, each composed of individual soil particles held together by the natural force of molecular attraction and cohesion. The condition is analagous to that of a popcorn ball, the soil particles corresponding to the individual grains of corn and the aggregate to the ball. Each aggregate is termed a granule; the process producing it is known as granulation; and the product is called granulated structure. A soil devoid of granulation is said to be structureless.

Tillage Provides Differential Stress. Granules split off along lines of weakness; the soil particles arrange themselves around a center of great cohesive pull as a nucleus. The tillage implement exerts an external stress that upsets the equilibrium existing between the cohesive forces within the soil mass. Localized centers of strong cohesion, together with surrounding belts or faces of weakness between, instantly come into being. The plow is a great structure-producing tool because it creates a systematic network of differential strains throughout the plow layer. But its potentialities are negative as well as positive, as we shall find later.

Structure-Aiding Agents. Tillage does not stand alone as a structure-producing agent. Other agents function actively in the same capacity. Four of these are of significant influence: (1) Alternate wetting and drying disrupts the soil mass along lines of cleavage where unlike curvature of moisture films sets up unequal strains. Repetition of the process brings about a slaking action yielding cubelike granules. Most of our dark soils respond to this agent. (2) Alternate freezing and thawing serves to weaken and even shatter structureless soils. Ice crystals grow in localized centers by the withdrawal of water from adjacent zones. The melting of the ice crystal leaves a point of weakness. Frost action paves the way for better granulation by tillage and by moisture fluctuation. (3) Disintegrated organic matter, being a relatively weak binding material, constitutes a plane of weakness and delineates the form of a granule. On soils well-stocked with organic matter, good structure can be maintained with the minimum of tillage effort. (4) Lime weakens the binding power of soil colloids, localizing their cohesive power, with the result that soil particles arrange themselves in clusters of fairly stable constitution.

These agents, singly or in combination, are not substitutes for tillage. Their action is too limited. They serve in a supplemental capacity. Though they raise the structural level materially, the main duty of developing a full structure rests on artificial manipulation — tillage.

EARMARKS OF GOOD STRUCTURE

To arrive at what constitutes the attributes of good soil structure, it is necessary to consider how this property functions in relation to the soil and to the plant.

What Soil Structure Must Offer. Full physical performance of a soil rests upon a wide range of duties, all of which are directly influenced by structure:

1. **Less Resistance to Root Penetration.** Granular structure affords larger pore space together with less resistance to root extension. That this freedom provided by an open soil is a definite factor in character of root system has been observed by crop investigators. A theory has been advanced by one that plants on highly resistant soils consume energy and substance in forcing their roots through the soil. Accordingly, a proper condition of structure eliminates this alleged waste of energy.

2. **Free Intake and Retention of Rainfall.** Normally in the corn belt, 25 per cent of the annual rainfall is lost to the crop by surface run-off, resulting in a deficit for crop use. Large pores common to a crumb structure facilitate a more greedy intake of surface water. Moreover, there is the further advantage of enlarged water capacity within the soil body by reason of the room between granules as well as that within the granule.

3. **Resistance to Erosion.** Granules erode less than do single soil particles. By lending stability to the soil body and lessening the amount of water that must run off over the surface, good structure fortifies against erosion. Findings by investigations ably support this principle.

Seven Cardinal Needs Basic to Advance in Tillage

1. Model structure profile
2. Standard rootbed profile for each crop
3. A measuring-stick for soil structure applicable to field use
4. Optimum moisture index for tillage
5. Optimum moisture calendar for tillage
6. Trash placement in structure profile
7. Model surface conformation for each season and crop

[1]Paper presented at the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December, 1931.

[2]Assistant professor of soils (extension), Ohio State University. Mem. A.S.A.E.

The erosion problem imposes the need of adjusting tillage to structural requirements for stability.

4. **Optimum Air Supply.** Without structural improvement our heavier soils exhibit sluggish air movement within the mass. By better aerating the soil, tillage stimulates the decay process, favors nitrification, and aids other air-requiring processes.

5. **Facilitate Trash Placement.** Merely covering trash in the manner of hiding a nuisance is insufficient. Its placement must be constructive; organic matter functions best if divided and distributed within the plow layer. The accomplishment of this end is materially facilitated by good granulation.

6. **Stable Traction.** Being an expression of structure, bearing value of soil is a dynamic property. Granular structure offers internal friction to the soil body. The structureless state, on the contrary, contributes to mobility and a plastic nature. Under a given rainfall a well-granulated soil affords more stable bearing for more days of the working season than can the same soil if ungranulated.

The Structure-Profile. The master duty of tillage is the building of a structure profile that fulfills the above requirements. What are the specifications of this ideal structure-profile? In the absence of experimental evidence, the functional requirements as already laid down must serve as a guide to our concept of a model profile:

1. **Model Profile.** A vertically graduated structure and consistency is needed, the lower zone to consist of the finest granules and the firmest degree of consistency. In successively higher zones granulation should coarsen while the consistency loosens. The whole is to be topped by distinctly coarse granules forming a loose layer immediately above the seed level; added organic matter to be intermixed with the lower half to two-thirds of the plow layer.

2. **Old Form Inverted.** In form, this is the old-type seedbed inverted. An analysis of the contrasting features leads to significant considerations. The old order consisted of a thin veneering of dust on the surface, produced by overworking and reducing to a structureless (single grain) condition. Beneath this and extending to the subsoil, the mass remained crude and undisturbed.

This condition was a natural product of the earlier types of tillage implement, most of which were surface-working only. Reference to the drag and log-roller is sufficient proof of this fact.

3. **Clods to Supplant Dust.** A dust veneer is a barrier to ready intake of rainfall, an encouragement to evaporation, and fatal to ultimate good tilth. The new order would supplant dust with clods on the surface. Really we should not be alarmed at clods on the surface; rather, perhaps we ought to welcome them. Within limits, clods are useful. They take the impact of raindrops and, while slaking down, reduce crusting. Then too, they serve as a baffle to slow up wind movement at the surface and in other ways mitigate against evaporation of soil moisture. Nor should we fail to realize that, in case of intertilled crops, clods are buffers against undue pulverization by the cultivator.

The size of surface clods (which are merely oversize granules) is necessarily subject to limitations. The size and gradation will necessarily vary with each soil type and the kind of crop grown. Furthermore, it would seem that they best form an intermittent covering and be so handled as not to interfere with germination of seed and emergence of the young plant.

4. **Standard to be Established by Experiment.** Since the specifications for the model structure profile call for structuralizing the full plow layer, new emphasis and problems in design of soil-working tools are suggested. The problem becomes more than that of deep-working versus shallow-working types of implement. Rather, it is more especially the manner of manipulation, starting with a soil existing in a given condition of structure and consistency and bringing it up to the model.

However, before design can be attempted, the soil technologist must first establish experimentally the standard profile. The specifications already mentioned are formulated from the observed principles of soil mechanics. Equally imperative with need of a model profile is the necessity of a measuring-stick for structure applicable to field use. Until both these are available, the designer, the soil technologist, and the farmer are much in the dark.

Crop Factor Modifies Structure Profile. So far we have considered the idea of a generalized profile. In field practice, we must include and deal with the modifying factor of crop. Crops differ in their rootbed requirements. Some are sharply sensitive to, while others are noticeably tolerant of, the physical conditions of the soil. Modifying the model profile to meet crop preference introduces an added factor:

1. **Kind of Rootbed Differs by Crops.** The potato thrives only in the most specialized conditions: Extreme granulation, loose consistency, great depth, open aeration, soil well-loaded with organic matter uniformly distributed, water content high but not incompatible with free aeration.

Oats appears indifferent to an elaborate rootbed and overprocessing may even prove harmful, as evidenced by the 10-year findings at the Ohio Agricultural Experiment Station on a soil possessing fair natural granulation:

Extent of Soil Tillage	Oats	Corn
No preparation	49.0 bu.	31.4 bu.
Disked	55.9 bu.	
Plowed	53.6 bu.	45.9 bu.

Corn, on the other hand, is fairly exacting as to rootbed, as demonstrated by eight years of results at the same station.

Not greatly unlike the potato, sugar beets are responsive to deep penetration, but prefer a finer grade of granulation and less aeration.

With tobacco, a high state of soil granulation is even more important than plant food.

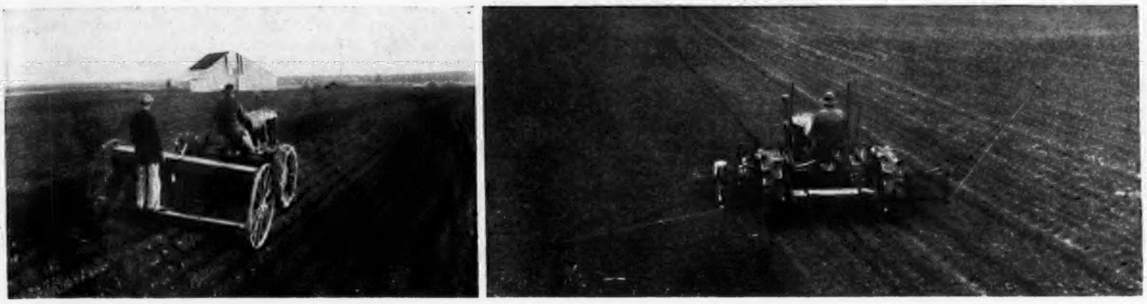
Obviously, the profile make-up must cater to the preference of the individual crop.

2. **Rootbed Index Also Needed.** Illustrating merely the existence of differences in crop requirements, this brief reference to individual crops fails to specify the precise need of each. Again, we are faced with the need of determining and setting up an index standard — in this instance — for rootbed based on crop preference. For each crop this would be a specialized form of the model structure profile. With such a guide, furnished by the agronomist, the rule-of-thumb method would be obsolete in modernized farming.

MANIPULATION OF SOIL TO CHANGE STRUCTURE

Tillage is the farmer's sole means of building structure to order. Moreover, while other agents are time-consuming, the action of tillage on structure is instantaneous. The energy necessary to effect a given degree of granulation is the same whatever the agent. The plow crowds its effort into a short space of time, whereas the natural forces of wetting and drying and of freezing and thawing spread over long-time periods.

Moisture the Key to Structure Making. In the structure-making process, the effectiveness of tillage depends upon the moisture content of the soil. This relation is a delicate, highly sensitive one. For any one soil, there exists an "optimum moisture" content for effective tillage. If tilled within the optimum range, the soil yields to maximum granulation; but if disturbed outside the "critical limits," granulation becomes feeble, or of poor quality, or nil, or negative. If manipulated, an overmoist soil undergoes destruction of existing natural granulation and may even puddle into a structureless, monolithic state. On the



Crops differ in their rootbed requirements. Some are sharply sensitive to, while others are noticeably tolerant of, the physical conditions of the soil. This must be recognized in field practice

contrary; undermoist soils, having their cohesive forces well equalized throughout the mass, are broken into large chunks by sheer force of the implement.

Soil Properties Controlling Optimum Range. Soils differ widely in their optimum moisture range for tillage. Rarely are any two the same, especially within a well-defined soil or agricultural section. Among the soil properties influencing the level and length of the range are chiefly: (1) Fineness of texture — coarse or sandy soils exhibit a low water content with a wide range, while fine or clayey soils offer a very narrow range at a fairly high level. (2) Organic matter content—high content of organic material raises the level and widens the range. (3) Colloid content — the higher the colloid content, the more restricted the range. (4) Lime supply — the presence of lime acts less influentially, but in the same direction as the organic matter factor. (5) Natural or existing structure — an already well-developed granular state makes possible a wider range at a higher level.

All of these factors operating as they do in varying degrees in any one soil, exert a composite effect and fix the optimum moisture level and range for that soil.

Optimum Index for Each Soil Type. It is desirable to establish the optimum range for each soil type. Laboratory investigations are now in progress in a few states seeking to devise a method of measuring the critical limits. When it is realized, as revealed by these and other findings, that a moisture change as small as a fraction of one per cent marks the difference between good and poor granulation, the need of deliberate attention to this angle of tillage becomes significant. In each state exist 50 to 100 major soil types and the determination of what may be termed the "optimum index" for each should prove a valuable contribution in behalf of tillage procedure.

Soil Calendar of Optimum-Moisture Days. A sequel development and one to be made feasible by the first is the determination of the number, frequency, and calendar distribution of days in the year when each soil type is suitable to be worked. Of necessity this would take the form of an experience table involving, on the one hand, effective rainfall, and, on the other, the "optimum index" for the soil type. Such an experience table would open up great potentialities. Providing as it would the normal expectancy of suitable days available for tillage in any season for each operation, it would make possible scaling the size of soilworking implement and power unit to the prevailing working period. It carries the hope of substituting a factual guide for present guesswork.

STRUCTURE UNSTABLE — DETERIORATION AND RESTORATION

Soil structure is unstable. It is a changing, elusive feature and subject to deterioration. Granulation may partially or wholly disappear, but in some soils it endures in a high state of development.

Destructive Forces. In an aging structure, cohesion becomes weakened by high humidity and rainfall. Dryness prolongs its life. Impact of raindrops is a damaging manipulating agent which can quickly break down a fairly good but fine granular condition. Granules weakened by a high water content of long standing are most susceptible to harm from beating rains. Obviously, in the problem of renewing structure, rate of rainfall is quite as vital as amount.

Resistance and Recuperation. Coarseness of granules slows up and fortifies against the work of destructive agents. They wear down more slowly and form lines of weak cohesion surrounding themselves that aid in the process of natural recuperation or of mechanical restoration. Therein lies a large argument for coarse surface versus a homogenous structure profile. Mechanical manipulation causes subdividing of the originally coarse granules into numerous smaller ones. As the season progresses, crop plants have attained size enough to provide shelter to the soil against the packing effect of raindrops, rendering rugged structural resistance less necessary.

Some soils are so disposed as to yield granules of great stability and resistance. Still others possess the power of self-granulation and can partially recuperate from the destructive effect of rainfall, unless quite severe.

The March of Granulation. The need for mechanically improving structure varies inversely with the degree of existing granulation. Soils differ greatly in the amount of natural granulation that they carry. The march of natural structure geographically is as follows:

Natural Structure	Soils Group	Geographical Location
Structureless	Podsol soils	Grey soils of northern New England
Modest granulation	Brown forest soils	Eastern corn belt and Northeastern states
Well developed granulation, stable	Chernosem	Eastern Dakota, Nebraska
Less granulation	Chestnut	N.-S. belt on west of Chernosem
Still less granulation	Brown	N.-S. belt on west of Chestnut

Within each of these great groups are wide differences due to individual soil type. In either case, structural condition is largely an expression of organic matter content of the soil. This constituent both lessens the need for mechanical manipulation and accentuates the effectiveness of it when applied.

SEQUENCE, FREQUENCY, AND MANNER OF MANIPULATION

It may be helpful to take stock of, and perhaps reappraise, some aspects of soil manipulation in the field. Certainly it is not amiss to orient our viewpoint on a few of these.

Lifting Versus Compression Action. In the aggregate the energy exerted in tillage is tremendous. But the manner of its application to the soil is of vast importance. The crude plow of the Egyptians, 5000 years ago, merely pressed its way through the soil unduly compacting that part of the soil mass in greater proximity to the tool.

Even up to our present time, much of the effort in soil preparation has been of a compression type, and localized on the surface of the soil. There followed the spike-tooth harrow, and next appeared the spring tooth harrow and early disk. They represent the evolution of, and the increasing impetus given the lifting principle in soil manipulation. Only yesterday we have seen this same principle embodied to a higher degree in the newer type, vigorous acting, disk and in the rotary hoe. We have come a long way from primarily compression to dominately lifting action. We are interested in the latter because it is more conducive to good structure.

It is to be recognized in this connection that the type of action must be properly related to the specific need of the soil. Sandy soils need and should receive compression. Since they are structureless, the less lifting the better for of poor contact of plow layer with subsoil, both necessitating a special type of compression which may be had by working through the upper zone as can be done by a disk set straight and weighted.

Regulate Amount of Tillage by Soil Type. The amount and vigor of tillage should be carefully adjusted to the exact resistance of the soil type. Too much force or agitation may overshoot the objective, resulting in partial granulation or in a granule which is too small. On the other hand, insufficient disturbance to fully overcome the natural resistance of the soil may fall short of yielding a completely structuralized condition. Likewise, as Ashby has shown, trash covering is more difficult on heavy soil in poor condition as against the same soil in fair condition. Sandy soil permitted, as he found, better coverage than heavy soil.

Failure to use a type of plow correctly suited to the soil type and its condition results in a poor structure. Extra supplementary operations are then required to overcome the damage done, or to complete the rootbed.

By shifting the time of plowing from spring to fall, one can substitute frost energy for horsepower and at the same time achieve better structural condition. Only the more resistant soils, however, lend themselves to this procedure.

Sequence of Operations. We have little information regarding the most effective sequence of tillage operations. In setting up the model profile, the desirability of a well-granulated zone in contact with the subsoil was specified and stressed. To this end preworking of the soil in connection with plowing should be helpful. The Nebraska Agricultural Experiment Station measured a ten per cent increase in corn yield to the credit of this sequence. Data are needed on other combinations of sequence.

Frequency of Tillage. Frequency of manipulation is determined by one thing — deterioration of structure. This principle conflicts with the idea of a rule-of-thumb guide to the number of cultivations that should be applied to intertilled crops. No greater fallacy has crept into farm practice and agricultural teaching than the no-weed-no-cultivation delusion. The classic contribution on mechanics of evaporation, offered 25 years ago by Buckingham, easily refutes this fallacy. We do need cultivation of soil expressly for reducing evaporation, irrespective of the presence of the weed factor. A granulated surface curtails evaporation. It is the duty of cultivation to establish and maintain this barrier to water loss. Since some soils are self-granulating, artificial renewal of surface structure is least needed on them. On the other hand, those farmers with light-colored soils, medium to heavy in texture and lacking in stability of structure, need to restore the condition by more frequent cultivation. Two cultivations in a season may suffice on one soil type, whereas on another, as many as four may be needed to effect equal saving in water.

CONCLUSION

In conclusion, it must be stressed that soil manipulation has for its intermediate objective, structure-making. That structure, in turn, must be so designed as to properly serve a biologic end and at the same time conserve the soil body intact.

Artificial Light and Orchard Pests

ORIENTAL peach moths and coddling moths, foes of the peach and apple crops, may be routed with the assistance of the photoelectric eye if experiments now being carried on by the New Jersey Agricultural College prove successful. These moths cause much damage by laying their eggs on the trees in question, but they will not lay when the temperature is below 60 F or in the daylight.

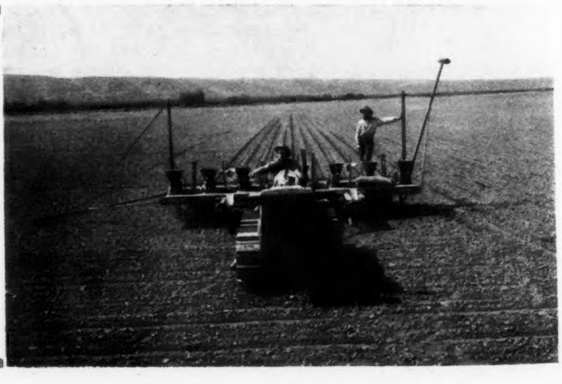
To defeat the moths it was decided to floodlight some experimental orchards and have the light turned on and off by photoelectric relays. These devices are set to operate when the light increases or decreases beyond certain predetermined limits. When darkness approaches, the photoelectric device causes the floodlights to be turned on; when daylight returns, it turns the floodlights off again. The moths, finding a state of continual daylight, are expected to be discouraged from their egg-laying in that particular orchard.

As the moths will not lay their eggs when the temperature drops below 60 F, a thermostat will be used to cut out the floodlights entirely under such conditions.

A foot-candle meter is used to measure the different light intensities at different parts of the orchards, to determine the minimum amount of artificial light necessary to stop the moths from laying. The trees will be examined at the end of the egg-laying season and results compared with the artificial light intensity at corresponding points. The cost of the artificial lighting will then be compared with the cost of spraying trees.

The experiment is being conducted by Dr. Thomas J. Headlee, entomologist for the New Jersey Agricultural Experiment Station at New Brunswick. Dr. Headlee has also found that the color of the artificial light used, as well as the amount of light, has some effect on the attraction or repulsion of the insects. He plans to experiment with various colors of artificial light in conjunction with the other arrangements.

We need to determine and set up an index standard for rootbeds based on crop preference. For each crop this would be a specialized form of the model structure profile. This would obsolete rule-of-thumb methods in tillage.



Tests of Laminated Bent Rafters[1]

By Henry Giese[2] and E. D. Anderson[3]

THE motive responsible for undertaking these tests came from the observations of the large number of curved-roofed barns which have sagged at the ridge.

The operation of restoring to its original position a roof which has failed is costly, and wholly unnecessary provided care is exercised in the construction. Investigation of such failures has shown the cause to be, for the most part, a slighting of materials in the construction of bent rafters. The farmers or carpenters probably fail to realize that the amount of material specified for rafter construction by the designer is necessary if there are to be no intermediate roof supports.

It was the purpose of these tests to investigate the comparative stiffness of laminated bent rafters constructed according to several different specifications and including the use of water-resistant glue.

Selection of Test Specimens. The first type of rafter selected for testing was the type of bent rafter most widely used — one made up of five 1x4s laminated, sometimes bolted and nailed, sometimes nailed only, and with different specifications for nailing.

Then, in an effort to economize in materials without reducing stiffness, a second type of rafter was designed which consisted of six 1x3s laminated. A solid rafter of this cross-section would be stiffer than one of the type comparable to the five 1x4s, since stiffness of a solid beam may be expressed as the reciprocal of the deflection. In the case of a solid beam supported at each end and with a concentrated load at the center, the stiffness may be expressed

$$\text{Stiffness} \propto \frac{EI}{PL^3}$$

or proportional to the first power of the width and the cube of the depth.

These specimens were not bent as they would be in actual practice since the tests were to be comparative only.

Solid specimens of the same dimensions as the built up rafters also were included in the test for purpose of comparison.

The laminated rafters were constructed of 1x4s and 1x3s — No. 2 yellow pine. The 1x3s were obtained by ripping 1x6s. The solid specimens were selected from No. 1 common commercial grade fir stock. All specimens were constructed 12 feet long.

Construction of Test Specimens. The laminated rafters were constructed as follows: The second course was nailed to the first with 4d nails at intervals of 18 inches to keep the two in alignment. The third course was nailed to the first two with 6d nails set staggered at either 4 or 6-inch spacing according to specifications. Additional courses were nailed to the preceding ones with 8d nails set staggered. When the last course was in place, the first was nailed to the others. The bolts, when used, were spaced 6 feet on centers. Fig. 1 shows the plan of breaking joints and spacing of bolts.

When glue was used, it was applied by means of a brush on a strip down the center of the specimen covering about half its width.

Apparatus. The apparatus for this test as shown in Fig. 2 was assembled in the agricultural engineering research laboratory at Iowa State College. The 10-foot gage length on each specimen gave a 12-inch overhang at each end beyond the support. The rafter was supported at one end by a 6-by-6-inch built up column approximately 18 inches high. The other end hung in a stirrup suspended from the scale beam of a Buffalo U.S. Standard scale. This scale was sensitive to two pounds, with a maximum capacity of 5100 pounds.

Load was applied at the midpoint by means of a turnbuckle which was anchored to the floor by two 2½-by-2½-inch angle irons. Round bearing contact was used at each point of support, with 3-inch bearing plates to prevent crushing of the wood.

A micrometer screw at the scale-beam end, together with the turnbuckle at the center, made possible the application of load at either place. A circular scale calibrated from 0 to 0.230 inches, which turned with the screw, afforded a convenient means for measuring deflection when the load was applied at the end. When load was applied at the center, the deflection was obtained by the use of an inside calipers inside the turnbuckle.

Procedure. In placing the specimen in the apparatus, the 10-foot gage-length marks were set directly over the end supports, and the clevis above the turnbuckle was clamped directly over the midpoint. In the case of the laminated specimens, the first or inside course was placed up. The dial on the micrometer screw was set at zero, and an initial load of 40 pounds was applied by tightening the turnbuckle. This initial load was applied to remove any play from the apparatus. Then load was applied at the scale-beam end by 10-pound increments, and a reading of the end deflection was taken following the application of each increment of load. When the extension limit of the micrometer screw was reached, the load was reduced to the initial 40 pounds, and the first test was repeated. This gave the effect of fatigue similar to that to which a rafter is subjected by repeated wind loads. When the extension limit of the micrometer screw was reached the third time, the additional load was applied at the center by tightening the turnbuckle to the extension limit of the apparatus in case fracture did not occur previously. When the load was applied at the center, the increment of load was increased to 20 pounds.

Results. A comparison of the characteristics of the different groups of specimens is shown in the accompanying graphs. A stress-strain diagram was constructed for each group by drawing average curves through all the plotted points for the three tests run on

TABLE I. RAFTER SPECIFICATIONS

Group	Spec.	Type	Nails	Bolts	Glue
1	1,2,3	Lam.-6-1x3s	2-8d. per ft.	2-⅝"@6'-0" o.c.	None
2	4,5,6	Lam.-5-1x4s	3-8d. per ft.	2-⅝"@6'-0" o.c.	None
3	7&8	Lam.-5-1x4s	2-8d. per ft.	None	None
4	9,10,11	Lam.-5-1x4s	2-8d. per ft.	2-⅝"@6'-0" o.c.	0.25# Per Spec.
5	12,13,14	Lam.-6-1x3s	2-8d. per ft.	2-⅝"@6'-0" o.c.	0.25# Per Spec.
6	15&16	Lam.-5-1x4s	2-8d. per ft.	None	0.25# Per Spec.
7	17&18	Solid-3x6s			
8	19,20,21	Solid-4x5s			

RESULTS OF TEST

Group No.	Spec. No.	Maximum Load (#)	Maximum Deflec. (in.)	Remarks	1st Deflection Load	1st Deflection Com. Stiff.	2nd Deflection Load	2nd Deflection Com. Stiff.
1	1	840	4.28	◐	412	1.34	572	1.38
	2	400	1.14	△				
	3	380	1.13	△				
2	4	730	2.89	◐	434	1.41	586	1.42
	5	660	2.96	◐				
	6	420	1.12	△				
3	7	480	2.80	◐	308	1.00	413	1.00
	8	420	2.49	◐				
4	9	2320	3.58	#	800	2.60	1540	3.74
	10	1520	2.15	#				
	11	2480	3.27	◐				
5	12	2440	2.28	#	1062	3.45	2070	5.00
	13	2040	2.27	#				
	14	2640	2.71	◐				
6	15	1320	1.77	#	798	2.59	1443	3.50
	16	1560	2.26	#				
7	17	2240	2.36	#	1145	3.72	2030	4.92
	18	2000	2.01	#				
8	19	2480	2.96	#	940	3.05	1820	4.41
	20	1760	2.17	#				
	21	2620	3.16	◐				

◐ Extension limit of apparatus # Fracture
△ Extension limit of screw

[1] Paper presented at a meeting of the Structures Division of the American Society of Agricultural Engineers, at Chicago, December 1931. Journal Paper No. B24 of the Iowa Agricultural Experiment Station.

[2] Professor of agricultural engineering, Iowa State College. Mem. A.S.A.E.

[3] Research fellow in agricultural engineering, Iowa State College.

each specimen. These points for each specimen lay very close to the average curve.

The fatigue shown in Fig. 3 is representative of that displayed by the group of unglued specimens. It will be noted that a smaller amount of additional set was taken on in the third test than the second. Four test runs were conducted on the first specimen, but when it was found that the additional amount of set taken on the fourth time was practically negligible, only three tests were run on the remainder of the specimens.

GROUP 1. The bending of the lower part of this curve (Fig. 4) indicates there was considerable slipping of one lamination upon the other, especially in the lower working limits. None of the three specimens showed any indication of failure at the extension limit of the apparatus.

GROUP 2. The shape of the curve for this group conforms very closely to that of the curve of Group 1. However, its location on the graph indicates for it a greater stiffness than for the first group. None of these specimens failed under maximum deflection.

GROUP 3. The specimens of Groups 1 and 2 showed much greater stiffness than the members of Group 3. This difference can be attributed to the difference in the amount of materials used. Each specimen was intact under maximum deflection.

GROUP 4. This group of three specimens showed characteristics quite different from any of the preceding ones. In the fatigue tests, the specimens returned almost to their original position when the load was reduced to the initial 40 pounds. The length of the straight line portion of the curve indicates greater elasticity than any previous group. Specimen 9 failed with a fracture of the bottom course in tension at the center. Also the glued joints loosened between each of the inner courses above the fracture. Specimen 10 also failed in tension in the bottom course at a knot one-fourth the width of the specimen. The glue joints were still sound except at the point of fracture. Specimen 11 gave no evidence of failure under maximum deflection.

GROUP 5. This group of specimens also showed the elastic qualities of a solid timber. The smaller increments of deflection indicate greater stiffness than the preceding one. Specimen 12 failed in tension of the bottom course. The fracture was diagonal from one side under the center to the spike knot one inch long, nine inches from the center on the opposite side. Specimen 13 failed at a common knot in the lower course, 6 inches from the midpoint of the rafter. Specimen 14 did not fail under maximum deflection.

GROUP 6. The curve for this group assumes very nearly the same shape as the curve for Group 4. However, its position on the graph indicates for it a lesser degree of stiffness. Failure of Specimen 15 occurred at a knot in the bottom course 8 inches from the midpoint of the specimen, and extending across half its width. With Specimen 16 the fracture originated in the bottom course at a spike knot 7 inches from the midpoint, and extending across half the width of the specimen.

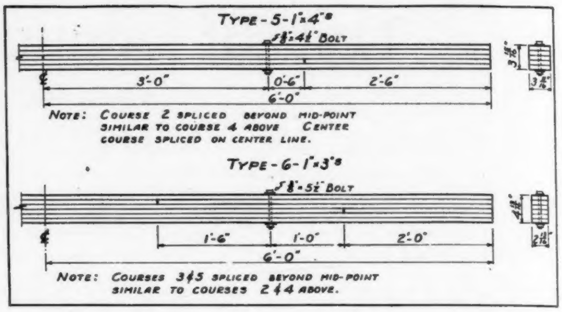


Fig. 1. This shows the construction of the test specimens in the Iowa tests of laminated bent rafters, including the plan of breaking joints and spacing of bolts

GROUP 7. Since these solid specimens were slightly narrower than the corresponding laminated specimens, a correction factor was applied to all the readings for this group. The straight line portion of this curve indicates greater stiffness for these specimens than for any of the preceding ones.

Specimen 17 did not fail under maximum deflection allowable in the apparatus. The fracture of Specimen 18 occurred in tension at a spike knot 12 inches from center, and then followed a diagonal course for 3 feet along a diagonal check.

GROUP 8. The elasticity of this group of specimens was greater than that of all other groups except the two preceding ones. The fracture of Specimen 19 followed a diagonal check on the lower side of the specimen. Specimen 20 fractured at a round knot 3 inches from the center. Specimen 21 did not fail under maximum deflection.

Working Limit of Bent Rafters. An auxiliary test was conducted to determine the working limit of bent rafters under actual conditions as found in a Gothic roof structure. This point, when found, might then be taken as a point for comparison of stiffness of the various test specimens.

In preparation for this test a templet was constructed (Fig. 5), in which a fine-grained redwood board, ⅝ by ¾ inch was bent in the shape of a rafter in a Gothic roof structure. This model was constructed to a scale of five inches equal one foot and bent, to scale, on a 24-foot radius.

Twelve inches, at the ridge, was considered the maximum deflection that would occur on an actual barn. This deflection was produced to scale, on the model, and the difference in deflection was calculated at the midpoint of the rafter on a 10-foot section, to scale, to compare with the length of the test specimens.

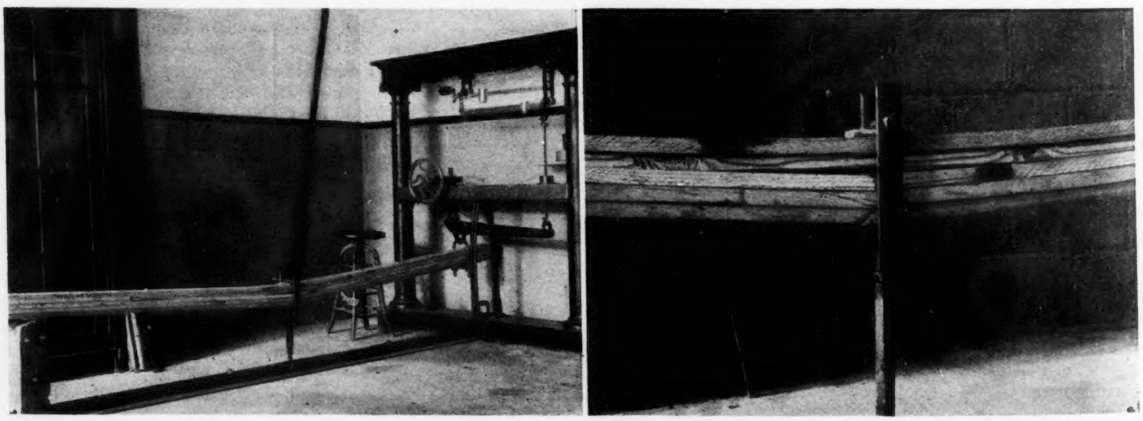


Fig. 2. (Left) Testing apparatus with a fractured specimen in place. (Right) Close-up view showing failure of a glued specimen (No. 9)

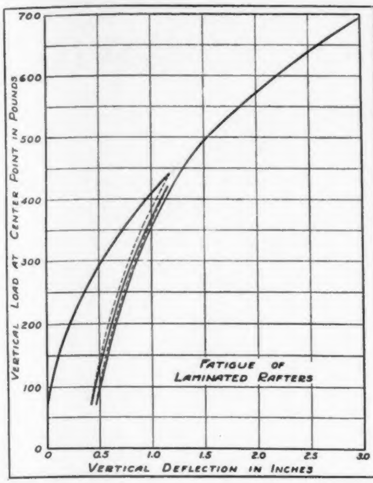


Fig. 3. (Left) Curves showing fatigue of laminated rafter

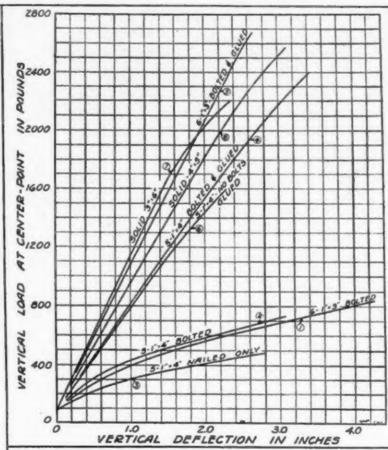


Fig. 4. (Middle) Stress-strain diagrams of different groups of specimens of laminated rafters

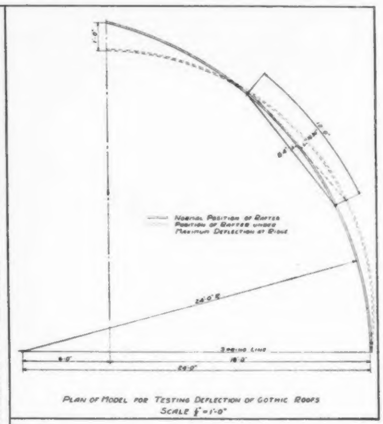


Fig. 5. (Right) Plan for a model to test the deflection of Gothic roofs. A ⅝ by ¾-inch piece of fine-grained redwood was used to approximate the deflection characteristics of bent rafters

One test was conducted with one end fixed and another with both ends free to secure as near as possible the maximum difference in deflection which might occur when different construction methods are used at the plate joint.

Analysis of Composite Graph. Basing our judgment upon the results of the test previously discussed, we may consider 2 inches as the maximum difference in deflection likely to occur at the midpoint of a 10-foot section of rafter as a result of the sagging of the roof at the ridge.

In analyzing the composite graph, the comparative stiffness of each type of rafter is expressed as a ratio of the stiffness of that group to the stiffness of the specimens of Group 3 using the latter as an index of value 1. These values are recorded in Table I, one value for maximum difference of deflection, and one for average difference of deflection for each type of construction.

(A) Unglued Specimens. At 2 inches difference of deflection, Groups 1 and 2 each show greater stiffness than Group 3.

With the comparative stiffness of Groups 1 and 2 determined as 1.38 and 1.42, respectively, it is apparent that there is a saving of material at the slight expense of stiffness in the use of 1x3s as compared with 1x4s. That stiffness is added to the rafter by the use of bolts is quite clearly shown.

(B) Glued Specimens. The effect of the use of glue in construction of laminated rafters was to give the rafters the elastic qualities similar to those characteristic of solid timbers.

Again using 2 inches difference of deflection as a point for comparison, it is quite apparent that all of the glued specimens were much stiffer than the unglued ones. The stiffness of the specimens compared with Group 3, for Group 4, consisting of 1x4s bolted, was 3.74; for Group 5, consisting of 1x3s bolted, was 5.00; and for Group 6, consisting of 1x4s not bolted, was 3.50.

When glue was used in construction, the 6—1x3 type of rafter showed a considerable advantage in stiffness over the 5—1x4 type in contrast to the case when the unglued specimens were compared.

(C) Solid Specimens. The solid specimens in each case showed greater stiffness than the corresponding dimensional laminated specimens except near the point of maximum deflection in the case of the 3x6 group. Above a deflection difference of 1.95 inches, the laminated specimens showed a greater stiffness.

Economic Feasability of Casein Glue. The casein glue used in these tests was a water-resistant brand of glue which was mixed in the ratio of 1 pound of glue to 2 pounds of cold water. The glue formed a thick paste after it was first added to the water, but after an interval of fifteen minutes it thinned out to a workable consistency.

The glue was applied between the courses with a brush in a layer half the width of the specimens, and thick enough to assure contact with both courses at lapped joints where there was a difference in the thickness of the boards.

An average of three-fourths pound of liquid glue, or one-fourth pound of dry glue, was used for each specimen. This glue may be purchased for 50 cents per pound in 10-pound lots.

The cost of glue for an average barn of dimensions 36 feet by 60 feet may be determined as follows:

Cost per rafter = length of rafter × glue per linear foot × cost per pound = 62 × .25 × .50 = 65 cents

Cost for 36-by-60-foot barn = number of rafters × cost per rafter = 31 × .65 = \$20.00

CONCLUSIONS[4]

1. A rafter consisting of five 1x4s laminated with 3 nails per foot and bolted with two ⅜-inch bolts 6 feet on centers is 1.42 times as stiff as one of the same type nailed with 2 nails per foot and not bolted.
2. A rafter consisting of six 1x3s laminated and bolted is 1.38 times as stiff as one constructed of five 1x4s not bolted.
3. A glued rafter of six 1x3s laminated and bolted is 3.6 times as stiff as an unglued specimen of the same type.
4. A glued rafter consisting of five 1x4s laminated and bolted is 2.6 times as stiff as the unglued rafter of the same type.
5. A glued rafter consisting of five 1x4s laminated (not bolted) is 3.5 times as stiff as an unglued rafter of the same type.
6. A rafter consisting of six 1x3s laminated requires only nine-tenths of the lumber of one consisting of five 1x4s laminated.
7. It is more important that bolts be used in the construction of unglued rafters than glued rafters.
8. In bent rafter construction it is important that the best material be used in the extreme fibres — the outer lamination next to the sheathing, and the inside lamination. Lower grade material may be used in the intermediate laminations.
9. The cost of glue in the construction of laminated rafters is 65 cents for each 2-foot section of length of structure.

[4]All comparisons of stiffness made in these conclusions are for a deflection difference of 2 inches at the center of a 10-foot gage length.

A Diesel Engine Designed for Tractor Service[1]

By C. G. A. Rosen[2]

THE development of the "Caterpillar" Diesel engine for the tractor service has involved years of engineering research to uncover the fundamentals upon which to base a practical design. In reviewing the evolution which has transpired, one is inclined to pause and reflect upon the value of experimental engineering to industry.

The pages of history reveal to us that Leonardo Da Vinci was the founder of the experimental method in engineering. This mediaeval Florentine genius was peculiarly endowed. He possessed the observing eye of the painter and sculptor; the penetrating faith of a philosopher and religionist; the cold, deductive logic of the mathematician, and the enterprising spirit of the inventor. These factors combined to make him an illustrious development engineer.

A phenomenon in nature commanded his undivided attention; impelled him to believe that a reason was behind its existence, and that a useful end was its purpose; invited the aid of mathematics to establish a law for its control and duplication, and inspired inventive effort to apply his garnered information to practical performance.

This is ever the ideal of experimental engineering — not to implore the fanciful to transform itself into an operating mechanism, but to harness stern realities into productive channels.

The "Caterpillar" Diesel is the result of intensive experimental effort applied to the solution of tractor service problems. These problems have previously impeded the adaption of the Diesel engine to the tractor, and have placed deterrent influences on the application of commercially available Diesel engines. Briefly, these problems may be summarized under (1) field servicing, (2) field operators, (3) dust exclusion, (4) fuel filtering, (5) dependable fuel supply on rough ground operation, (6) sustained full power operation, (7) reliable variable load performance, (8) positive starting, and (9) low maintenance.

To correctly evaluate these problems, the description of the Diesel principle, as applied to the "Caterpillar" Diesel, may be pardonable at this point. It operates on the four-stroke cycle compression ignition principle and burns fuels commercially known as Diesel fuels without the assistance of spark plugs or external heated surfaces.

[1]Paper presented at a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December, 1931.

[2]Diesel engineer, Caterpillar Tractor Company.

The working process of this engine may be studied with reference to Figs. 1, 2, 3, 4, 5, and 6. For convenience, the intake stroke is used as the starting point in the explanation of the cycle of operation. Fig. 3 shows diagramatically the engine in cross section and indicates those parts which function during the intake stroke. (The description of this stroke, as well as the subsequent strokes, can also be referred to Fig. 2 for orientation on the actual engine.)

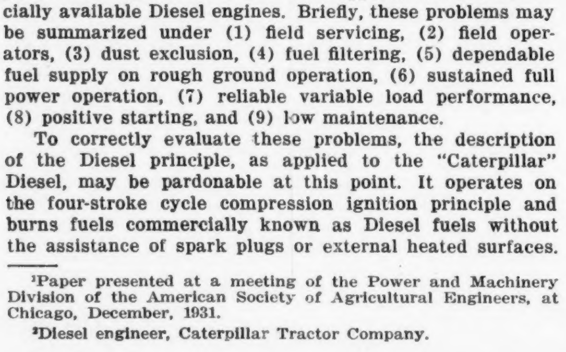
The intake stroke is quite similar to the intake stroke of a gasoline engine, with one exception: Pure air only is drawn directly into the cylinder through the intake valve (C). The intake valve, therefore, is merely an air intake valve in the Diesel and never functions the movement of fuel-laden gases, such as take place in the gasoline engine.

No throttles are placed on the intake line between the outside atmosphere and the intake valve. The air cleaner is therefore required to be considerably larger than commonly used on the gasoline engine as the piston always inhales a full cylinder of air, regardless of load or speed.

The second stroke, or compression stroke of the Diesel cycle, is illustrated in Fig. 4. During this event, all valves are closed and the piston moves up crowding the air within the cylinder into an extremely small clearance space causing the temperature of the air to rise well above 1000 degrees (Fahrenheit). The compression ratio is 15½ to 1, and therefore produces a compression pressure of 520 pounds per square inch at the upper extremity of the stroke. This compression pressure is probably 100 pounds higher than normally required to obtain satisfactory ignition for starting, but the excess temperature is considered advantageous in burning fuel quickly, and provides a safe margin as the cylinders wear and piston rings become less effective seals.

The temperature of compression in the "Caterpillar" Diesel is therefore ample to insure reliable starting and guarantee continuous operation at idling and light loads.

Fig. 4 illustrates the introduction of an auxiliary chamber, G, which has communication with the main combustion chamber, D, through openings H. While the air is being compressed in the main cylinder, D, highly-heated air currents pass through openings H into the auxiliary chamber G. This air accumulated in chamber G is set aside particularly for the purpose of igniting the fuel introduced into it on the subsequent stroke.



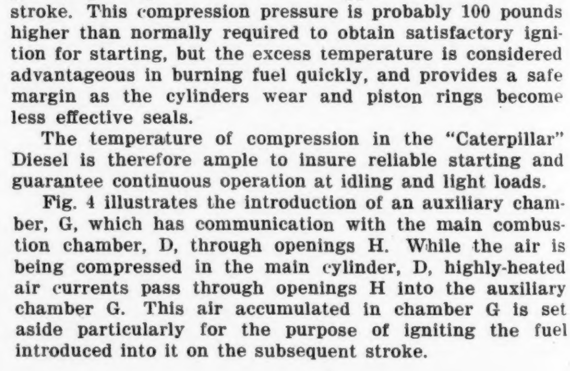


Fig. 1 (Left) Fuel pump side of the "Caterpillar" Diesel "60" tractor. Fig. 2. (Right) Starting motor side

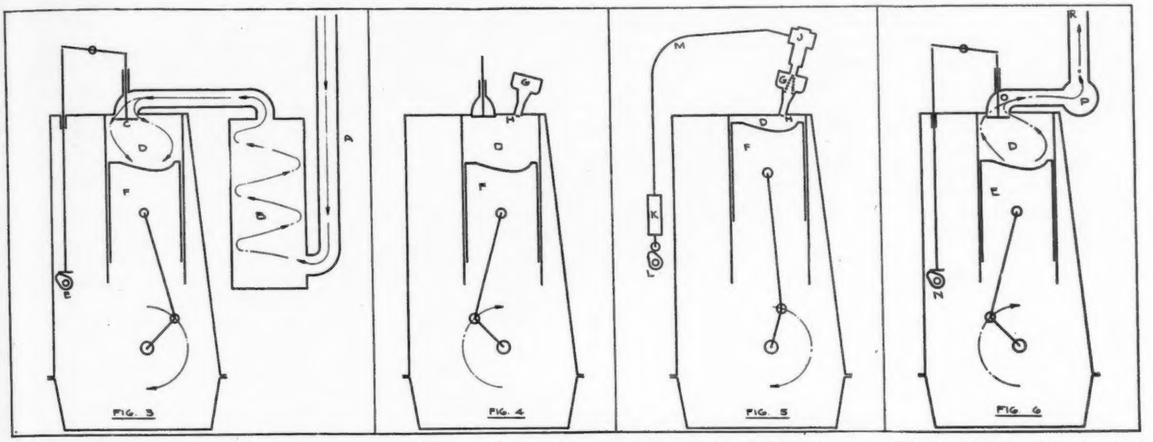


Fig. 3. Stroke 1 (intake) of the Diesel cycle. Fig. 4. Stroke 2 (compression) of the Diesel cycle. Fig. 5. Stroke 3 (power) of the Diesel cycle. Fig. 6. Stroke 4 (exhaust) of the Diesel cycle

Stroke 2 is therefore quite similar to a gasoline engine in action, with the exception that compression is carried approximately 6½ times higher. This compression pressure calls for more rugged frame construction and a heavier reciprocating string.

The power stroke is illustrated in Fig. 5. At this point, the fuel injection apparatus here manifests its influence and action in the cycle's functioning.

The fuel injection valve, J, is in direct communication with the auxiliary chamber, G. A fuel channel, M, connects the injection valve, J, with fuel pump, K. This fuel pump is actuated by cam L.

Inasmuch as the Diesel ignition means is by compression alone, and is devoid of any spark plugs or electrical ignition devices, the fuel is introduced into the ignition chamber at a time shortly before ignition is desired, which time is a little before the end of compression. By this procedure the entering fuel particles become heated by the high temperature of the compressed air and ignite. Inasmuch as there is a short interval required for the heating of the fuel particles, fuel pump K begins the injection of fuel through valve G slightly prior to the exact time of ignition. The injection function is therefore accomplished by cam L in correct relation with the plunger of fuel pump K so that a measured quantity of fuel passes from K, motivating the fuel in injection line N causing the lifting of the fuel needle in the lower end of injection valve G. The cross section of the injection apparatus is illustrated in Fig. 8. The result of this action is the injection of a measured quantity of fuel in the form of a mist, directly into the heated air currents moving within chamber G. The nozzle through which the fuel passes into auxiliary chamber G is of the single-orifice type provided with a self-cleaning pintle.

The contact of the minute fuel particles with highly-heated air currents passing up through channels H causes the fuel to become quickly heated and ignited.

With the continuance of injection, the introduced fuel is enveloped by flame, becomes gaslike in consistency, and by virtue of the higher pressure developed in the auxiliary chamber, travels at high velocity through openings H into the main combustion chamber D where considerable air is available for the completion of burning of the fuel.

The constricted volume of auxiliary chamber G permits of the combustion of only a small amount of the charge of fuel to be utilized as a match, or igniting flame, to the remainder of the introduced fuel for load operation. The major portion of the fuel is therefore consumed in the main combustion chamber D. Power is thus obtained and the piston moves down as the pressure of the burning and expanding gas above the piston forces the piston downward.

In Fig. 1 the supply system required for furnishing the necessary fuel to the injection apparatus is illustrated. Fuel flows from the storage tank T through the fuel line S into the fuel transfer pump U. This fuel transfer pump serves the dual purpose of forcing the fuel supply for the engine through the filter box V for removing dirt and other foreign matter, and also for the purpose of by-passing entrained air back into the fuel tank through line Y. After the fuel has been cleaned in filter box V, it enters the fuel pump suction manifold from which clean fuel is distributed to each individual cylinder's fuel injection pump.

The exhaust stroke is directly comparable to that of a gasoline engine and provides the necessary means for the rejection of the waste products of combustion out into the atmosphere.

The point to particularly emphasize in the discussion of this Diesel cycle is that the entire fuel system is built around a single orifice for the injection of fuel into the cylinder. The use of multiholed orifices is not considered satisfactory for field-tractor service. The use of a non-choking single-holed injection orifice was considered of prime importance.

Next in importance was the use of individual pumps for each cylinder. A single-holed orifice channeled to a single plunger fuel pump provides the most reliable means for the introduction of fuel into a cylinder. Whatever fuel leaves the discharge valve in the fuel pump must find its way into the auxiliary combustion chamber.

A simple and highly-reliable fuel pump was chosen for the purpose of measuring the required amount of fuel for each power stroke. This measurement is designated by the governor. Usually the suction valve of the fuel pump is the most vulnerable point in Diesel operation. The substitution of both the suction valve and the customary by-pass valve by accurately-machined ports eliminates a common source of trouble in Diesel engines. There is therefore no occasion for the grinding of delicate valves in field operation. The simple means of controlling the quantity discharged by the actuation of the fuel pump plunger by-pass scroll, as employed on the Bosch pumps, greatly adds to reliable operation.

By referring to Fig. 8, the action of the fuel injection pump can be studied. The plunger barrel is cut away near the upper portion of its length. The plunger is shown with the scroll just ready to uncover the lower edge of the by-pass port. The injection pump plunger is therefore in position to permit the by-passing of the fuel between the plunger and the check valve to flow back through the by-pass. By the rotation of the governor regulating spindle, the position of the scroll with respect to the by-pass port will be altered, thus permitting a greater, or a less effective length of discharge period.

The beginning of injection is obtained during the upward movement of the plunger, when the upper edge of the plunger covers both the upper edges of the suction port and the by-pass port. The fuel trapped between the plunger and the check valve will force open the check valve on the continued upper movement of the plunger, causing the pintle valve to lift by virtue of the pressure exerted on the differential area of the fuel valve needle. Injection continues until the scroll of the plunger uncovers the lower edge of the by-pass port.

The employment of a single-holed orifice in the auxiliary chamber, or pre-combustion type of engine, permits the use of low injection pressures. In the "Caterpillar" Diesel, 1250 pounds is employed, which is approximately one-third that of the usual Diesel injection pressure. The fuel injection apparatus is therefore initially endowed with at least three times the life of the average fuel injection apparatus.

The use of the single-holed nozzle permits the use of the auxiliary chamber, or pre-combustion chamber, as the simplest method of providing rapid distribution and penetration of fuel into the air of the main combustion chamber. Normally, in the Diesel engine it is necessary to disperse the spray through multiple orifices for satisfactory distribution. In the "Caterpillar" Diesel the pre-combustion chamber so conditions the fuel that it permeates through the air content of the main combustion chamber by being carried on highly energized gas vehicles which speedily reach the outer limits of the main combustion chamber.

The Bosch type of fuel pump lends itself quite readily to quick governing. The rapidity and smoothness of the combustion processes are also responsible for a marked degree of flexibility. The sensitiveness of the governor and its ability to alter speeds quickly and precisely in correct coordination with the features already mentioned, makes the "Caterpillar" Diesel possess accelerating qualities equal, if not better, than the average gasoline engine. The improved type of governor is driven from an independent drive, directly through a set of helical gears from the crankshaft. In this way, the governor-driven shaft is free from any impulses such as normally obtained from cams and other disturbing influences. Directly beneath the governor weights is located a vibration dampener to permit the large energy of the governor to have free gyroscopic action. A lever guided by the fork of a governor sleeve transmits the governor's directed movement to a bell crank in the governor control housing. One end of the bell crank is attached to the casing in which is located the variable speed governor spring. The other arm of the bell crank is directly connected to the regulating spindles illustrated in Fig. 8. The wish of the operator as to speed change is transmitted to the quadrant located on the side of the governor control spring housing.

With the foregoing cross-section view, this paper will now focus attention on the problems which have beset the progress of the Diesel for tractor service.

The problem of field servicing cannot be overly emphasized when considering the application of the Diesel engine to the tractor. The operating controls must be similar to those employed on gasoline engine tractors. In the "Caterpillar" Diesel the identical speed control is available at the driver's seat, as employed on the gasoline tractor.

The fuel injection apparatus, at best, is a delicate piece of mechanism. It must not be tampered with or adjusted by the operator. In the "Caterpillar" Diesel the fuel injection apparatus is given constant timing at the factory. The discharge of each pump is calibrated so that all units will synchronize properly with the governor, no matter where they may be installed. All the injection apparatus is given eight hours of wearing-in service so that the operation of the fuel injection pump, and of the fuel injection valve, may properly pass inspection under operating conditions.

Specially designed machines have been constructed to provide the means of calibration and testing so that all injection apparatus is ready for immediate operation upon installation on any "Caterpillar" Diesel. With each tractor, a complete set of spare fuel injection apparatus is furnished, which is immediately available for the production of continuous power.

These contributions to the Diesel engine art have removed from the operator the responsibility of being a Diesel engineer, and permit the better grade of tractor operators to obtain satisfactory operating results. The maintenance man is charged with the responsibility of reasonable care in preserving cleanliness of fuel and in the prevention of contamination of the interior of the fuel injection channels.

A new standard for Diesel engines has been set in the complete inclosure and dust-proofing of vital operating parts. This has been accomplished without minimizing accessibility, and without endangering lubrication by contamination from fuel system leakage.

Fuel filtering is accomplished at one point in which two stages of cleansing take place within one body. The filtering elements are readily accessible from the outside and are quickly cleaned and returned to the body. Where filtering is accomplished at several points, it is rather unusual to find them all clean at the same time.

The cylinder block is so designed that pockets are provided to catch the drip from the fuel pumps, and the drainage from the fuel valves. These cast-in pockets are directly beneath each individual fuel pump. A drain plug is located on the outside of the case for the ready removal of whatever leakage is contained in this chamber. The tappet actuating the fuel pump plunger is housed by a cylindrical dam over which an umbrella plate prevents the passage of any fuel into the crankcase lubricating oil beneath.

The Diesel engine requires a solid stream of fuel from the fuel tank to the fuel injection valve. The introduction of any air in the fuel lines results in stoppage due to the inability of the cylinders to obtain the necessary quantity of fuel for power development. The fuel supply tank must operate at varying levels, and therefore when the tractor is working over rough ground the fuel will be constantly "swashing" and moving. To maintain a constant flow of fuel from the tank to the fuel transfer pump, a special type of fuel tank is provided on the "Caterpillar" Diesel tractor. A special non-surging tank is attached to the bottom of the main tank which permits the quieting of fuel sufficient to maintain a solid head of oil above the tank outlet.

To guard the operator from running his fuel so low that the tank outlet will be uncovered during rough ground operation, or when climbing steep pitches, a magnetic gage is provided on the fuel tank indicating the various oil levels, and showing the minimum or low level position below which it is unsatisfactory to operate. The fuel tank

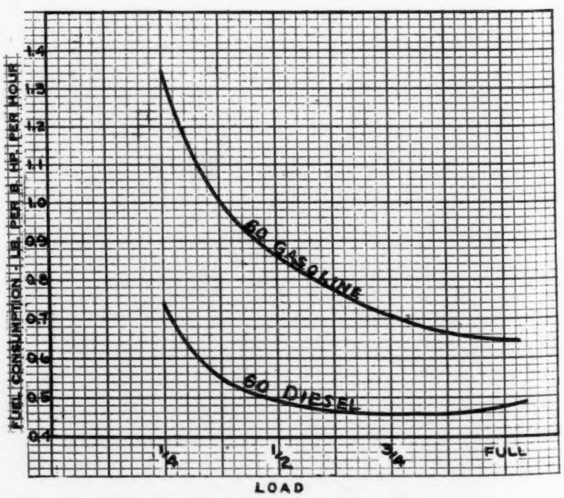


Fig. 7. Comparative fuel consumption of "Caterpillar" gasoline and Diesel "60" tractors

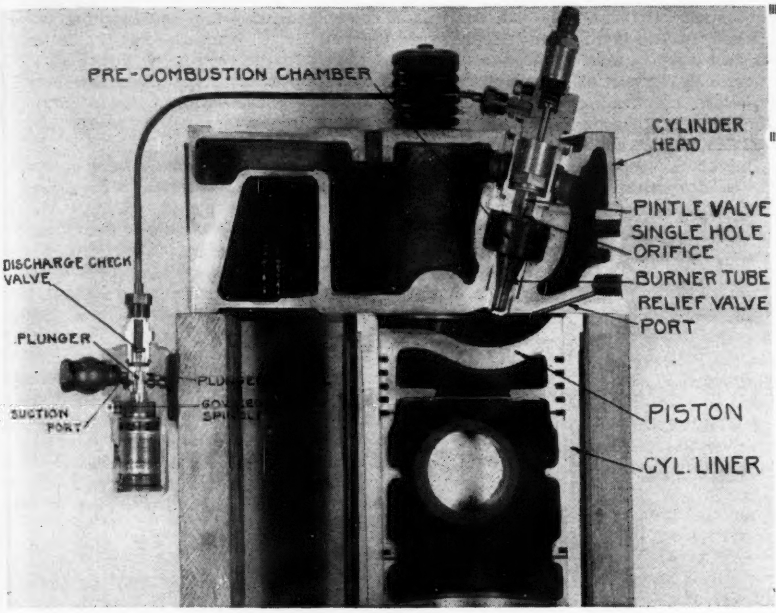


Fig. 9. Cross section views of fuel injection pump and fuel valve of the "Caterpillar" Diesel tractor

is also elevated sufficiently so that all of the pipe lines, fuel filter and injection pumps, are self-priming and keep filled with solid fuel by virtue of the gravity head of the tank and the design of the fuel pipe system.

An improved method of bleeding the supply lines to the fuel pumps is used. On the suction connection to each pump is provided a needle valve and a bleed hole. The elevation of the fuel tank is sufficient to provide a gravity head permitting the flow of fuel to wash out any trapped air in the supply lines through these bleeder holes when the bleeder needles are open. The system is therefore quickly cleansed of air, and as long as the injection pumps are supplied with solid fuel around the suction chamber, the remainder of the system can be very simply primed by the application of a wrench to the priming cams which actuate the fuel pump tappets and which are located on the outside of the cylinder blocks in the positions noted, directly below the individual fuel pumps.

To maintain rated full power over extended periods of operation, a combustion system is required which will provide clean combustion over the entire operating range so as to prevent the accumulation of any unburned fuel particles at vital injection points, or in gas sealing mechanisms.

The first prerequisite for such a condition is the need of a fuel nozzle which will maintain itself over extended periods, and which will preserve proper atomizing characteristics without frequent cleaning, regrinding, or adjustment. The status of the air within the combustion chamber at the time of fuel introduction must be such as to allow the rapid comingling the fuel particles with oxygen. In the choice of the precombustion system of combustion, positive ignition is guaranteed, and the fuel injected into the precombustion chamber is so conditioned by the thermal reactions therein as to guarantee the fuel's rapid combustion within the borders of a specially designed main combustion chamber.

The main combustion chamber is carefully coordinated in design with the precombustion chamber, so that the conditioned fuel, or combustible mixture, will burn in a regulated fashion at the desired rate. The latest methods developed by scientific research for the prevention of detonation and combustion roughness, have been incorporated in the composite combustion chamber design to guarantee automatic volume control of the burning gases. By this advanced combustion chamber method, a rapid transformation of the injected fuel into heat energy is obtained, and clean combustion is the result. Reliable injection of atomized fuel, maintained by simple means, and clean and regulated combustion, obtained by self-regulating control methods, guarantees sustained full power operation. The necessity for tinkering and readjustment of the fuel injection apparatus in the field, which was so customary on Diesels of a few years ago, is entirely eliminated in this improved method of combustion.

The precombustion chamber always endeavors to consume its quota of fuel within its limited borders, thus maintaining a temperature status surrounding the injected fuel which predetermines positive ignition at all loads and speeds. At low speeds and light loads, the main combustion chamber, due to its larger surface, tends to cool down, but the precombustion chamber is so limited in radiating surface that temperature is always available for ignition regardless of load or speed. Variable load in idling control are essentials of prime importance in tractor operation and are satisfactorily provided in the precombustion chamber of this Diesel.

Positive starting under all climatic conditions must be available to the tractor Diesel. By the use of an auxiliary gasoline engine, powered through a Bendix to the main engine flywheel, a constant source of starting energy is available, which can continue its influence for extended periods, if necessary. Spasmodic starting impulses are not sufficiently reliable on equipment required to earn money by virtue of hours of work produced.

It is very desirable to provide continuous power in whatever starting means are employed on a tractor Diesel. Air starting is therefore not entirely satisfactory as it requires replenishment of air as soon as the starting tank is exhausted. Air starting also imposes difficult design conditions in the cylinder heads for the accommodation of starting air valves. Valves and air compressors are not kept sufficiently clean under tractor service conditions to maintain proper seating. The operating difficulties are therefore considerably increased in air starting systems. Electrical starting devices are not only expensive, but are not permissible on tractors due to the problems of obtaining satisfactory storage battery installation. Heavy shocks on rough ground operation are extremely disadvantageous to storage batteries.

Starting is further facilitated by passing the water of the starting motor cooling system into the vicinity of the precombustion chamber. The starting motor exhaust gases are also diverted into a heat exchanger in the intake manifold for warming the air entering the Diesel cylinders during starting operations. The control of this heating is adjustable to climatic conditions.

In Fig. 2, the gasoline starting motor is shown directly attached to the side of the Diesel cylinder block. To proceed with starting, the gasoline engine is given a starting impulse by means of the hand starting crank. The exhaust gases are employed for heating the intake manifold while the gasoline engine warms up. Power from the gasoline engine is imparted to the main Diesel through the engagement of the clutch lever providing the Bendix with energy impulse for engagement and rotation of the Diesel flywheel. Compression of the Diesel cylinders is established by draw-

ing the compression release lever from "start" to "run" position. With compression fully established, fuel is introduced to the cylinder by the lifting of the fuel pump control lever from the "stop" to the "run" position. This fuel pump control lever is indicated directly below the circular gasoline tank on the flywheel end of the Diesel. As soon as the Diesel operates on its own power, the Bendix automatically disengages and the starting motor is stopped. To stop the Diesel it is only necessary to drop the fuel pump control lever to "stop" position.

The matter of low maintenance has been a vital consideration in the design of the "Caterpillar" Diesel. The average Diesel has been heralded for its ability to save money on its economical consumption of cheap fuel, but many have required attention to the reduction of maintenance. Improper combustion has been the root of the major maintenance evils of the Diesel. In the "Caterpillar" Diesel, the automatic nature of combustion control, and its ease of maintenance, result in low maximum pressures being impressed upon the pistons in a graduated manner, thereby reducing vibration and voiding destructive effects common to vibratory disturbances, thus insuring long life to bearings and crankshafts.

The rapid and efficient method of combustion results in low exhaust gas temperatures, which insure long life of exhaust valves and their seats. The cleanliness of combustion assists in preserving the proper lubricating film on the cylinder walls, thereby maintaining correct piston ring functioning, reducing liner and piston wear.

The extreme care exercised in proper balancing of all mechanical details of the "Caterpillar" Diesel provides uniform and long life to the wearing parts. Parts requiring replacement due to concentrated wear are reduced to the minimum size and simplest possible construction to insure lower cost of replacement.

The reputation of the Diesel as an economical oil-burning power plant is well established. The extent of this economy depends quite naturally upon the cost of the fuel consumed, when comparing with gasoline engines. Inherently the Diesel develops power at low fuel consumption. In order to take maximum advantage of this fact, the fuel cost per gallon should be as low as consistent with good performance. By this it is understood that cheap Diesel fuels are usually low-grade oils and that the average higher-speed Diesel quite definitely limits the character of the fuel within restricted specifications. The precombustion engine, however, is quite capable of burning high carbon low-grade fuels, and the "Caterpillar" Diesel will burn any clean fuel which will flow freely through the supply pipe lines. The cheaper grades of fuel are therefore acceptable provided climatic conditions permit their freedom of flow in the fuel system.

In the precombustion chamber Diesel a small amount of fuel is wasted to the precombustion chamber for the purpose of guaranteeing positive ignition at idling, slow speed, and light load, even though this wastage slightly increases the specific fuel consumption rate. The practical advantages gained are sufficiently outstanding to warrant this practice. The conditioning of the fuel within the precombustion chamber for the subsequent complete combustion in the main combustion chamber, provides the desired cleanliness of combustion. A slightly higher rate of fuel consumption is therefore not reflected in a smoky exhaust.

Direct comparisons of economies of Diesel tractors with gasoline tractors are therefore in order. At rated full power under correct carburetor adjustments, the "60" gasoline tractor consumes 7 gallons of gasoline per hour. The "60" Diesel burns 4½ gallons of Diesel fuel per hour. Considering the average misadjustments existing in the field on carburetor engines, the gasoline tractor fuel consumption suffers a further disadvantage by indicating increased fuel rates. The Diesel tractor, however, is provided with sealed adjustments which cannot be altered or tampered with in the field, and the opportunity is therefore inherent in the Diesel for maintaining consistent fuel consumptions.

An analysis of the comparative fuel consumption curves of the "60" gasoline and Diesel tractors (Fig. 7) indicates the possibilities of even greater economies under variable load operation. The average tractor varies considerably in load factor during a year's operation, and the intervals of reduced power are all to the advantage of the Diesel and unfavorable to the gasoline tractor.

Fig. 8 indicates a saving over extended hours of operation when considering full developed power alone. Over a year's time it is quite conceivable that the savings can be increased 20 to 25 per cent over the values indicated by virtue of the economic advantages of the Diesel under variable load operation. These curves have been plotted on the assumption that the "60" gasoline engine fuel consumption, at full power, is 7 gallons per hour, and that the "60" Diesel fuel consumption is 4½ gallons per hour.

The "Caterpillar" Diesel is designed for the economical utilization of power. It has incorporated features destined to minimize service problems. It has reduced operating annoyances to the very minimum, and has placed in the hands of the average tractor owner a piece of equipment capable of producing continuous work in the hands of a tractor operator who "lets well enough alone," and who is content with obtaining the results for which the tractor was intended and sold.

Specifications of the "Caterpillar" Diesel Tractor

Drawbar horsepower (maximum)	63
Belt horsepower (maximum)	75
Drawbar pull in pounds at governed speed and maximum drawbar horsepower (sea level):	
First	12,425
Second	9,285
Third (standard)	6,470
Third (special)	5,360
Speeds in miles per hour:	
First	1.9
Second	2.6
Third (standard)	3.7
Third (special)	4.4
Reverse	1.4
Diesel engine	
Number of cylinders	4
Bore	6⅛ in.
Stroke	9¼ in.
Speed	650 rpm
Shipping weight of tractor (approximate)	25,000 lb.

Engineering Standardization[1]

I HAVE been asked by a good many people where to start a standardization program.

It is a case of all roads leading to the engineering department. I have yet to see a drafting room which is operating on the old method, without uniform practices, that is sending to the shop blueprints that have uniform designation of parts, uniform phrasing of dimensions on those parts, uniform methods of specifying finishes. The variety of fits between shafts and bearings in a drafting room of that kind is remarkable. Very often the man in the shop has to make his own fits and use his own ideas as to how the things should be made.

Some draftsmen will use tolerances; some will use limits; no two use the same formula for the designing of the same parts. I have in mind the standardization of gears undertaken under my direction. No two of the draftsmen had the same formula for designing gears Most of them used a certain formula for designing the strength of the gear tooth and I doubt that one of them knew that it was advisable, if not necessary, to design a gear for wear.

The sad thing in gear designing is the prevalence of the cut-and-dry method; they know a certain sized gear will operate with a certain horsepower, and if they want to increase the horsepower of the motor, they increase the gear sizes, and experiment in their gear-manufacturing departments, and in their transmission departments.

After the drafting-room practice has been established, it then comes to the point of standardizing on parts.

[1]From "Engineering and Shop Standardization as a Means of Reducing Overhead," by Thomas R. Jones, A.S.A. Bulletin, December, 1931.

Stationary Spray Plants for Commercial and Farm Orcharding[1]

By H. E. Lacy[2]

INFORMATION presented in this paper was obtained by the survey method. A visit was made to each orchard having a stationary spray plant, and as much information obtained as possible.

Georgia is a producer of large quantities of fruits and nuts, all of which have to be sprayed to insure quality. The nut case bearer and the leaf case bearer are limiting the crop of pecans in the South, but spraying has been found to control them to the point where a crop of nuts may be had in the worst infested areas.

At the present time there are fifteen orchards in Georgia being sprayed from stationary plants, the most of which are owned by apple growers of Habersham County. There are several in pecan groves and one in a 160-acre peach orchard. Most peach growers think the cost would be prohibitive because of the short life of peach orchards. The survey showed that the average cost of the complete system installed was $31.16 per acre, which would be only $3.00 per acre annually if the orchard lasted ten years. This is not a high cost for such dependable spray plants as these fruit growers have installed, and indications are that peach growers will soon be using this type of spray system.

The first stationary spray plants in Georgia were installed by growers who had orchards on such steep land that it was almost impossible to get about in them with portable sprayers. The advantages of stationary over portable sprayers have proven so great that fruit growers are putting them in on level lands. Every owner stated that if his orchard was level he would still prefer the stationary plant.

Some of these first plants were just experiments by the growers. In some instances they used the pump from an old portable outfit, with a "Model T" Ford engine to furnish the power. These systems worked well; in fact, they were an improvement over portable sprayers, but in some cases the pump was not strong enough to stand the high pressure needed for piping to distant trees. These small pumps are being replaced now by regular stationary pumps, which are giving excellent results.

The Ford engines are proving a satisfactory source of power. Three of the growers visited used single-cylinder stationary engines; two used tractors; two, electric motors; four, Bean Le Roi engines; and the others, Ford or Chevrolet engines. The power ranged from 6 to 22 horsepower, and in each case was sufficient.

Five of the fruit growers visited used concrete tanks. Ten used wooden tanks, which in most cases were from discarded portable plants. The capacities ranged from 250 to 500 gallons for these tanks, which are used in pairs, one for mixing while spray is pumped from the other. The commercial orchardists used 1000-gallon wood or concrete tanks. Some of the growers had used wooden tanks for a year or two and later built concrete ones to get away from trouble caused by small pieces of wood from the wooden tanks stopping up a nozzle.

In practice it was found necessary to round out all corners in the bottoms of the concrete tanks to prevent their filling with spray material by settling.

All but one or two of the plants were housed. The houses used were inexpensive, the average cost being about $75.00. All of the growers agreed that it was better to house the plants.

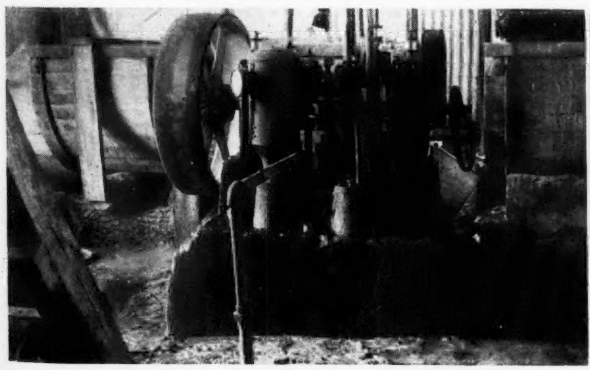
It seems that the most important part of the stationary plant is the pipe. In one instance there was a stretch of 2200 feet of ½-inch pipe. There is no wonder it caused trouble. The owner wanted to bunch his men on a small area, but was unable to do so. In fact, he had nine spray parties which were scattered over 400 acres of orchard. This made it impossible for him to look after his men.

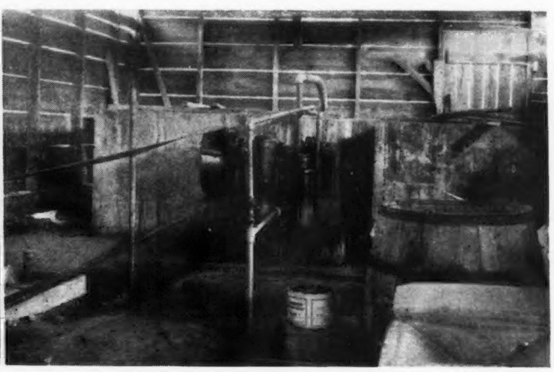
A good system was used on a 600-acre apple orchard at Esom Hill, Georgia. This layout may not be perfect, but it is working well, with no faults visible at present. The farthest point from the pump in this orchard is more than a mile, and when operating at a 550-pound pressure nine spray parties can be bunched in an area of about 10 acres.

One central main runs the entire length of the orchard with laterals branching off on both sides at right angles every 600 feet. From these laterals are shorter laterals branching off in the same manner ever 200 feet, and extending 200 feet on both sides of it. This puts the risers on the square system 200 feet apart. These short 200-foot laterals are all of ¾-inch pipe. The first 400 feet of the longer laterals are 1-inch; the next 1600 feet of 1¼-inch pipe. Part of this 1¼-inch pipe may extend a short distance along the main. The next 1600 feet of the main is of 1½-inch pipe, with the remainder of 2-inch pipe. There may be a more economical layout than this that will give

[1]Paper presented at the Rural Electric Division session of the 25th annual meeting of the American Society of Agricultural Engineers, at Ames, Iowa, June 1931.

[2]Research agricultural engineer, Georgia State College of Agriculture. Assoc. Mem. A.S.A.E.





Stationary spray pumps with (left) wooden tanks and (right) concrete tanks

(Left) Stationary pump mounted on a truck for moving from one orchard to another. (Right) Spraying apples by the stationary plant method, at Esom Hill, Georgia

just as good service, but this one cost only $20.43 per acre for 600 acres and it seems well to consider it seriously.

About half the orchardists used black pipe and half used galvanized. They were all satisfied, but as the first plant was installed in 1925, it may not be a fair test as to the lasting qualities of the pipe. Only one man has his pipe run on the surface, the others have it underground. In one or two instances the pipe was pulled into the ground with a tractor and subsoil plow, at a cost of $1.48 per acre. It is much faster and more economical than any other method used.

The length of hose used ranged from 150 to 400 feet, depending on the distance between risers. In most cases two men worked on each hose, one pulling the hose while the other did the spraying, changing places every thirty minutes. According to the commercial orchardists this was the best system to use. They also advised working the men only ten hours a day. After ten hours they will stay at one tree too long and waste the spray material.

Table I gives the cost of installing eight stationary plants, based on cost figures kept by the owners.

Only three of the orchardists visited kept books on the labor cost of spraying with both the stationary and the portable systems. All of them were confident that they saved from 40 to 50 per cent on the labor of applying the spray. The three labor cost records are given in Table II.

The comparison of other costs, such as gas, oil, and spray material, varied with the size of orchard. In some cases they were more for the stationary plant, and in others they were considerably less. For instance, where only one or two hose were used, the gas and oil would be more for the stationary plant, but where eight or nine were used, it would be much less. The greatest saving is in labor and repairs.

I will state the advantages and disadvantages of the stationary plant just as they were given by the owners.

The advantages are:

1. "Saves time, labor and material"
2. "Enables us to spray promptly, and when needed"
3. "Can operate in wet weather"
4. "No time lost in refilling"
5. "Great reduction in cost of upkeep; repairs the same as for a single portable system"
6. "Enables us to spray rough, steep hillsides that could not be sprayed with portable outfits"
7. "Hired men had rather work with stationary systems"
8. "Does not pack soft ground after rain"
9. "Cheaper to apply spray with stationary plant, cuts labor one-half"
10. "Stationary spray plant operates at higher pressure and insures a better coverage"
11. "Only one unit to operate; for commercial orchards it saves hiring a mechanic"
12. "Does away with having to keep a pair of horses for each portable outfit"
13. "No damage to cover crops, and there are no gullies started by wheel tracks"
14. "Spray men do not have to repair outfit; therefore, there is less loafing."

It was hard to get the owners to admit that there were any disadvantages of their stationary spray plants in comparison with the portable outfit. Out of the fifteen plants visited, they gave only three disadvantages and they were not very serious ones:

1. "When there is a breakdown, all the men have to stop work"
2. "There is a possible lack of agitation in the pipe line causing spray material to settle out"
3. "There is some waste of material from the pipe line at night and at the end of each spray."

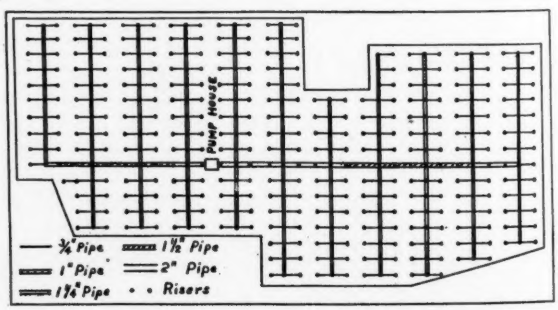
The stationary spray plant has proved to be a success in Georgia wherever tried. It is practical, efficient and economical in its operation as has been demonstrated by fruit and nut growers in all sections of Georgia.

Table I. Cost of Installation on Eight Stationary Spray Systems in Georgia

Orchard number	Installation cost	Acres in orchard	Cost per acre
1	$ 2,564.96	100	$25.65
2	2,679.79	75	35.72
3	854.74	12	71.22
4	1,455.00	34	42.79
5	12,258.96	600	20.43
7	1,100.00	45	24.44
8	6,309.00	350	18.02
9	4,407.50	400	11.01

Table II. Comparison of Labor Cost for Stationary and Portable Plants

Orchard number	Acres sprayed	Cost for One Spray		Saving per cent
		Stationary	Portable	
5	600	$265.20	$735.00	64.0
6	160	71.32	132.50	46.0
8	350	294.00	385.00	23.6



Layout of pipe lines for spraying a commercial orchard

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture. Requests for copies of publications abstracted should be addressed direct to the publisher.

The Timber of Corsican Pine (Pinus Laricio Poiret) ([Great Britain] Department of Science and Industrial Research (London), Forest Products Research Bulletin 6 (1930), pp. VII + 40, pls. 4, figs. 15).—This report presents the results of an initial series of investigations into the structure of Corsican pine wood, its seasoning qualities, strength, woodworking properties and uses.

The experiments demonstrated clearly that Corsican pine timber of the quality used can be kiln-seasoned rapidly and easily with very slight structural damage. It is extremely tolerant of high temperatures. There is a general tendency for the knots to split, but this does not detract from the value of the timber for most of the uses to which it is likely to be put. Corsican pine can be readily seasoned when piled in stick in the open. The degrade under severe conditions has been found to be less than that resulting from normal kiln-drying, which itself was small.

The timber has a mechanical strength of an average value among the pines of medium density. When well grown it is almost as strong as Scots pine, and when so grown may be considered as superior to the latter timber in strength when used as a post or column. The timber is not as heavy as Scots pine, nor is it usually so hard, which would indicate that it is easier to work. The timber does not shrink nor swell, either in the radial or tangential direction as much as Scots pine, and this property associated with its disinclination to cup or warp would make it a more useful timber for certain classes of joinery. The timber is inclined to be brittle, especially when air-dry, and should not be used in positions where it would be subjected to sudden shocks.

The fiber saturation point of the timber is at about 27.5 per cent moisture content. There is no shrinkage until this point in seasoning is reached. When the strength of the timber in compression parallel to grain is compared on a basis of rate of growth, it is found that the optimum condition to produce strong timber is a rate of growth corresponding to about ten rings to the inch.

It was found that there was no difficulty in injecting creosote or water solutions into Corsican pine. In fact, it is considered that this species is more amenable to treatment than Scots pine and is probably the easiest species to treat of the more common conifers. The timber can be treated successfully either under pressure or by the open-tank process, but it is especially suitable for an empty cell treatment as a deep penetration can be obtained in conjunction with a large recovery of injected oil.

The Care and Repair of the Home, V. B. Phelan (Garden City, N. Y.: Doubleday, Doran & Co., 1931, pp. XIV + 306, figs. 30).—This book is a brief popular treatise on home maintenance and repair. It contains the following chapters: Inspection of the house and its equipment, foundation walls and basements, exterior walls, interior walls, roofs and roof drainage, doors and windows, weatherproofing and insulating, heating and ventilating, plumbing and water system, painting and varnishing, electricity, and miscellaneous.

Garden Tractors on Long Island, A. A. Stone (Farmingdale, N. Y.: State Institute of Applied Agriculture, 1929, pp. 24, figs. 16).—The results of a survey of the use of garden tractors in the truck garden industry of Long Island are presented, together with a historical statement relating to the history of farm tractor development and especially of the garden type of tractor.

Construction of Agricultural Buildings, T. Gesteschi (Konstruktion Landwirtschaftlicher Bauwerke. Berlin: Julius Springer, 1930, pp. VIII + 284, figs. 426). — This is a technical treatise on the design and construction of farm buildings written from the German viewpoint. It pays attention especially to the structural engineering features of the work and devotes considerable attention to stress distribution in roof members and the like. It contains chapters on dwellings, roofs, stalls, grain storages, silos, implement sheds, vegetable storages, and bridges and water towers.

Fruit and Vegetable Storage, L. P. McGuire (Tropical Agriculture [Trinidad], 6 (1929), No. 10, pp. 279-284).—A summary of current literature regarding the optimum storage and transport temperatures for fruits and vegetables, which are either indigenous to or may be cultivated in the tropics, is presented.

A Study of the Influence of Herbaceous Plant Cover on Surface Run-off and Soil Erosion in Relation to Grazing on the Wasatch Plateau in Utah, C. L. Forsling (U. S. Department of Agriculture, Technical Bulletin 220 (1931), pp. 72, pls. 2, figs. 29).—This is a contribution from the Intermountain Forest and Range Experiment Station of the U.S.D.A. Forest Service. It presents the results of 15 years' measurements of precipitation, surface run-off, and erosion from summer rains and 7 years' measurements of melted snow run-off and erosion on two experimental watersheds on the Wasatch Plateau in central Utah.

The average annual precipitation on the areas studied was 29.51 inches. Soil moisture studies showed that on the experimental areas there was no contribution to the underground water supply from summer rains and that this supply is fed by the melting of the snow in the spring. Only 4.6 per cent of the average annual surface run-off was caused by summer rainstorms when there was a 16 per cent cover of vegetation, but this run-off caused 84.5 per cent of the erosion. After the vegetation had increased to 40 per cent of a complete cover, only 1.3 per cent of the annual run-off was from summer rains. Degrees of slope, character of drainage system, and chemical and physical properties of the soil were found to be more or less permanent factors which influence run-off and erosion. The degree of temperature, duration, and distribution of cold and warm periods, and the distribution of snow on the watersheds were the chief additional factors influencing the percentage of surface run-off from melted snow in the spring. Quantity and intensity of rainfall in a storm and the moisture content of the soil influenced summer rainfall run-off.

The quantity of sediment eroded by summer rainfall run-off varied more or less directly with the quantity of run-off, although it was influenced to some extent by the size of run-off, the trampling of livestock, and the dryness of the soil. The increase in the density of the vegetation from 16 to 40 per cent of a complete cover and the replacement of certain plants by others with more extensive and more fibrous root systems reduced the rainfall surface run-off 64 per cent, the rainfall erosion 54 per cent, and the melted snow erosion 57 per cent.

The results in general indicate the importance of herbaceous vegetation in reducing rainfall run-off and floods and in controlling erosion.

Orchard Drainage in the Medford Area, Jackson County, Oregon, M. R. Lewis and A. Work (Oregon Station (Corvallis) Circular 100 (1931), pp. 24, figs. 9).—This is a report of investigations carried on under a cooperative agreement between the station, the U.S.D.A. Bureau of Public Roads, and Jackson County, Oregon. It reports the results of studies, covering a period of 16 months, which indicate that the high water table found in parts of the area is responsible for serious orchard problems. Information is given on practical methods of drainage which are primarily of underground character.

[Agricultural Engineering Investigations at the Wisconsin Station] (Wisconsin Station (Madison) Bulletin 420 (1931), pp. 48, 49, 51-55, figs. 5).—It is reported that experiments with dense concrete tile have shown increased endurance in peat soils. When located in mineral soils the tests showed that concrete tile actually improved with age and were approximately 26 per cent stronger than when laid in peat soil. Large-sized concrete tile were more durable in peat than in the smaller sizes.

The results of studies of soil erosion in southwestern Wisconsin, conducted in cooperation with the U.S.D.A. Forest Service, are briefly summarized, these having been noted previously in Research Bulletin 99 of the station.

The Use of Logs and Poles in Farm Construction, T. A. H. Miller (U. S. Department of Agriculture, Farmers' Bulletin 1660 (1931), pp. II + 26, figs. 33).—Practical information is given relating to the chief points to be observed in building with logs and poles.

Manufacture of Dimension Stock from Northern Hardwoods, A. O. Benson (U. S. Department of Agriculture Circular 163 (1931), pp. 62, figs. 27).—The purpose of this circular is to provide information on the manufacture of dimension stock from material now unutilized in lumber production. The results presented are based primarily on studies made at typical lumber plants manufacturing dimension stock and represent the best current methods of operation and cost accounting.

The Trench Silo, J. C. Grimes and M. L. Nichols (Alabama Station (Auburn) Circular 59 (1931), pp. 8, figs. 3).—Practical information is given on the construction of the trench silo. It was found that a long, shallow trench is cheaper than a short, deep one. The cost of filling a trench silo is less than that for an upright silo.

[Agricultural Engineering Investigations at the Alabama Station] (Alabama Station (Auburn) Report 1930, pp. 9-11).—The results of studies in agricultural engineering, some of which have been previously noted are reported.

In weed control studies by E. G. Diseker, tests of various methods of precultivation indicated that factors such as depth and time of plowing, time of harrowing, and the use of the jointer and coulters had little or no effect on subsequent weediness of the cotton crop. An adjustable spike-tooth harrow used on sandy soil reduced the weed infestation from 75 to 78 per cent without seriously injuring the stand of cotton. The rotary hoe was a satisfactory implement for the cultivation of young corn and cotton during a dry season on both Black Belt and sandy soils.

Experiments by Diseker with machinery for harvesting and planting oats showed that the windrow harvester when used with the pick-up attachment on the combine was better adapted to harvesting oats under Alabama conditions than the combine alone.

A study by A. Carnes of the factors affecting the design of equipment for utilizing solar energy to heat water resulted in the development of a practical design, which consisted of a glass-covered insulated box containing an absorber made of 0.25-inch copper tubing soldered in the valley of galvanized corrugated roofing. The absorber surface was painted black. The water to be heated was circulated through this tubing and stored in an insulated tank. Sufficient heat was furnished by 30 square feet of exposed absorber to raise the temperature of 30 gallons of water from 68 to 115 degrees (Fahrenheit) in an average of 3 hours on sunny days. A formula for the design of other capacity absorbers follows: $Q = AT/d$, where Q equals British thermal units of heat desired, A equals area of absorber exposed at right angles to sun's rays, T equals number of degrees of temperature through which water is to be heated, and d equals thickness of metal in the absorber surface.

In the tractor lug studies by J. W. Randolph, the coefficient of rolling friction for the single wheel in Norfolk sand was found to be extremely high. The rolling resistance of a wheel with lugs varied with reference to lug position. Maximum resistance was obtained when the lug was 2.5 to 2.75 inches ahead of center for a 1.25-inch lug and from 3.5 to 4.5 inches ahead of center for a 2.5 inch lug. Lugs tended to prevent the wheel from sinking into the soil, but they increased the rolling resistance. Laboratory results obtained from a single wheel with a smooth rim checked closely with results obtained by the Jaudasek formula. The average rolling resistance of the wheel with lugs in Norfolk sand also checked closely with the results calculated by the Jaudasek formula, but as the lug entered the soil a peak of resistance was developed which was much higher than the calculated resistance. This peak depended upon lug size, lug spacing, and soil hardness. After the lug passed over the bottom wheel center, the rolling resistance was found to be less than the calculated resistance.

Studies by M. L. Nichols of the various soil constants which best indicate the physical factors affecting tillage led to the conclusion that the Atterberg consistency constants are the most satisfactory indexes to the physical properties of the soil. It was found that a definite relationship exists between friction values, shear, resistance to compression, and these constants. The general reaction of a soil to an implement also was found to be a function of the physical properties indicated by the Atterberg constants and could be accurately predicted at any moisture constant.

Cost of Pumping and Duty of Water for Rice on the Grand Prairie of Arkansas, B. S. Clayton (Arkansas Station (Fayetteville) Bulletin 261 (1931), pp. 48, figs. 2).—The results of a study, conducted by the U.S.D.A. Bureau of Public Roads in cooperation with the Arkansas Experiment Station, are reported in detail.

Preliminary Report on the Ground-Water Supply of Mimbres Valley, New Mexico, W. N. White (U. S. Geological Survey, Water-Supply Paper 637-B (1931), pp. II + 69-90, pl. 1).—This report, prepared in cooperation with the state engineer of New Mexico, relates to the supply of water that occurs below the surface of the Mimbres Valley in southwestern New Mexico.

The results indicate that the present irrigators in the Mimbres Valley are reasonably secure in their water supply provided no large additional pumping developments are made. The quantity of water stored in the underground reservoir is very large, but the annual recharge of this reservoir is relatively small. It is considered unwise to formulate plans at this time for any large additional pumping development.

Prevention of Wind and Fire Losses to Farm Buildings, H. Giese (Iowa Station (Ames) Circular 127 (1931), pp. 23, figs. 31).—Attention is drawn to some of the easily observed preventive measures for the reduction of farm building losses resulting from wind and fire. Information is given on wind resistive construction and fire resistive construction. Considerable space is devoted to considerations in farmstead planning, with particular reference to building design. A list of 12 publications dealing with wind and fire losses and their prevention is included.

Report on Experiments Carried Out at the Karachi Model Testing Station on a Model of a Flumed Regulator, C. G. Hawes and H. S. Kahai (Bombay (India) Public Works Department, Techanical Paper 31 (1929), pp. [3] + 7, pls. 9, fig. 1).—Studies of certain points in flume design are reported. These show that to minimize the loss of head through a regulator which is flumed it is definitely better to have a 1 : 10 expansion on the downstream side than to have a 1 : 5 expansion. The loss of head through such a regulator is not influenced to any appreciable extent by the shape of the ease waters of piers. The 1 : 5 cut water is so little better in regard to loss of head than the curved cut water (with a radius equal to double the width of the pier) that it will not pay to adopt 1 : 5 cut waters.

It is also concluded from the experiments with two piers in the throat that the splitting up of the water passing through the throat by means of piers into small streams has very little effect on the loss of head through a regulator, and that the introduction of piers into a regulator will not, therefore, affect appreciably the loss of head which will obtain in practice through the regulator.

A note by W. A. Evershed is included.

Report on Farm Electrification Research, compiled by G. W. Kable (C.R.E.A. Bulletin [Chicago], 6 (1931), No. 1, pp. 79, figs. 4).—The results of a survey of problems for solution on the use of electricity in agriculture are presented in this report. The first part summarizes the progress of investigations of different types which have been conducted. It contains also an analysis of agricultural development and a listing of some of the major economic and production problems in which electricity may be involved. It also proposes a plan and a program for the continuation of research activities. The second part classifies by subject the investigations under way and proposed, and in some cases brief statements of results are given. A list and description of research agencies engaged in rural electrification are included.

Knock Rating of Motor Fuels, C. H. Barton, C. H. Sprake, R. Stansfield and O. Thornycroft (S.A.E. [Society of Automotive Engineers] Journal (New York) 28 (1931), No. 6, pp. 636, 641).—Experiments conducted by the Institution of Petroleum Technologists are reported, in which various fuels, both straight-run and blended, were tested in the Ricardo, Delco, and Armstrong engines under three different sets of conditions and were rated in terms of blends of a high value and a low value straight-run gasoline, benzene, and heptane and Iso-octane and heptane. The last method gave a greater degree of fluctuation in knock intensity than the benzene-heptane blend.

Meters for Farm Equipment Studies ([C.R.E.A.] National Rural Electric Project, College Park, Md., Report 4 (1931), p. 1, figs. 3).—A simple cost meter and special portable watt-hour meters are briefly described and illustrated.

Geology and Ground Water Resources of Western Sandoval County, New Mexico, B. C. Renick (U. S. Geological Survey, Water-Supply Paper 620 (1931), pp. VI + 117, pls. 10, figs. 3).—This report, prepared in cooperation with the state engineer of New Mexico, deals with the geology and ground water resources of an area covering about 1,150 square miles in the western part of Sandoval County, New Mexico.

The investigation was made primarily to determine artesian prospects of the area. It was found that, although flowing wells are not in general to be expected in the area, there are good prospects of obtaining satisfactory supplies of water for domestic and stock uses and probably also for irrigating gardens.

Effect of Extractives on the Strength of Wood, R. F. Luxford (Journal of Agricultural Research [U.S.], 42 (1931), No. 12, pp. 801-826, figs. 2).—Studies conducted at the U.S.D.A. Forest Products Laboratory are reported. Four distinct methods were used to determine the effect of extractives on the strength of redwood, western red cedar, and black locust, namely, (1) sapwood was compared with heartwood, (2) redwood heartwood from which the extractives were partly removed by forcing cold water through in the direction of the grain was compared with adjoining unextracted heartwood, (3) the outer portion of a kiln-dried redwood block in which the concentration of extractives had been increased by the transfer that is normal during kiln-drying was compared with an adjoining interior portion of lower extractive content, and (4) sapwood of redwood soaked in redwood extractives was compared with normal sapwood.

The results showed that extractives affect the strength properties of these woods to an extent depending on the amount of extractives, the species of wood, the moisture condition of the piece, and the mechanical properties under consideration. Of the properties considered, the compressive strength parallel to the grain showed the greatest increase because of the normal infiltration of extractives in the change of sapwood into heartwood. The modulus of rupture was next in order of effect and shock resistance the last. In fact, the shock resistance appeared to be actually lowered by extractives under some conditions. Extractives changed the strength of western red cedar less than that of black locust, although black locust has a smaller percentage of extractives.

Annual Report of the Department of Water Supplies and Sewage Disposal for the Year Ending June 30, 1930, W. Rudolfs (New Jersey Stations (New Brunswick) Bulletin 521 (1931), pp. 47, figs. 26).—Preliminary studies on experimental sprinkling filters by Rudolfs, H. Heukelekian, and N. S. Chamberlin dealt with four experimental filter media consisting of crushed stone, slag, gravel, and 0.5-inch wire mesh, and having an effective depth of 5 feet.

The gradual building up process, regardless of filter media, took place over a considerable period with no definite demarcation between the building up and the regular operation of the filter. In the process of building up the zone of nitrification

moved downward, and considerable quantities of ammonia were lost into the air. The greatest suspended solids removal occurred in the roughest media, whereas the greatest ease of unloading was exhibited by the smoothest material. Considerable direct oxidation occurred. The biochemical oxygen demand reduction on the wire mesh amounted to 25 per cent. The greatest B. coli reduction occurred in the gravel, followed by slag and crushed stone. The effectiveness of the filters as a straining device was greatest in the upper layers, with particular reference to suspended solids removal, biochemical oxygen demand, and B. coli reduction. The percentage of biochemical oxygen demand removal increased with increased loads.

Experiments by Rudolfs on the distribution of protozoa before and after sloughing showed that the numbers of organisms in the film around the stones of the filter bed do not increase in proportion to the increase of thickness or weight of the film. As soon as the thickness of the film decreases, the numbers of organisms increase. The rapid change in numbers of organisms occurs throughout the bed, and free swimming organisms occur sooner in the effluent than do the stalked protozoa.

The results of other experiments on reaction adjustment of acid sludge by Rudolfs and with Trenton sewage sludge by Rudolfs and I. O. Lacy are also reported.

Poultry Housing and Poultry House Equipment for Montana, H. E. Cushman (Montana Agricultural College (Bozeman) Extension Bulletin 115 (1931), pp. 20, figs. 19).—Practical information is given on the planning and construction of poultry houses and equipment to meet conditions in Montana.

Flood Irrigation, H. E. Murdock and H. L. Lantz (Montana Agricultural College (Bozeman) Extension Circular 17 (1931), pp. 7, figs. 6).—Practical information is given on the subject.

Milk Products Waste Treatment: Report No. 3, E. F. Eldridge (Michigan Engineering Experiment Station (East Lansing) Bulletin 36 (1931), pp. 35, figs. 12).—Further studies on the treatment of milk waste products are reported, including preaeration studies and the biological filtration of whey solutions.

The results in general showed that septic tanks and all other methods which involve anaerobic bacterial action can not be used successfully with milk products waste. Broad irrigation on land is a suitable means of disposal. Chemical precipitation using lime and copperas will remove a portion of the milk solids from the waste if properly controlled but is not recommended owing to cost. Activated sludge, if properly controlled, will remove about 65 per cent of the milk solids but is expensive and difficult of operation and is not recommended.

Biological filtration over gravel, crushed stone, or slag was found to provide an efficient, relatively economical, and simple method of milk wastes treatment. The filter must be at least 7 feet deep and should be composed of stones with a graded size of from 1.5 to 3.5 inches. The waste should be applied at a rate not to exceed 1,000,000 gallons per acre per 24-hour day. The filter should not be operated longer than from 10 to 12 hours daily. The strength of the waste applied should not exceed 1,600 parts per million, provided it be an ordinary milk waste. Wastes higher in carbohydrates, such as whey, can be much stronger. A solution of whey containing as high as 10 per cent of that by-product can be treated on the biological filter provided the filter has been previously built up with the bacterial flora or the whey contains some milk waste or sanitary sewage.

Suggestions are given on construction and operation and on the treatment of combined sewage and milk waste as practiced at Mason, Mich.

Light Frame House Construction (Federal Board for Vocational Education Bulletin 145, rev. (1931), pp. XII + 216, pl. 1, figs. 164).—This publication was prepared by the Federal Board for Vocational Education in cooperation with the National Committee on Wood Utilization and is the second edition. It contains technical information for the use of apprentice and journeymen carpenters, and it includes chapters on framing methods for small buildings; foundation sills and girders; columns, joists, and bridging; walls, partitions, and roofs; floors, sheathing, siding and shingles; interior trim; miscellaneous items; physical characteristics of wood; and grading of lumber.

A Survey of Irrigation Practices in the Rice Industry of Calauan, Laguna, A. L. Teodoro and E. Bataclan (The Philippine Agriculturist (Los Banos, P. I.), 20 (1931), No. 2, pp. 93-100). —The results of this survey indicate that there are actually two periods in which water is needed for rice irrigation in Calauan, Laguna. The first period, comprising the land preparation, requires a constant supply of water for soaking and for puddling the fields for a period varying from 38 to 50 days. The greatest amount of water is used when the fields are being puddled before they become set. The water is most needed during the period of intermittent irrigations. The total number of days of intermittent plant submergence varies from 55 to 65 days.

Tests on Gas Grain Treater for the Control of Smut, J. Kienholz and W. K. Smith (Northwest Science, 4 (1930), No. 4, pp. 101, 102, 114).—Tests conducted at the Washington Experiment Station on the gas grain treater for the control of smut are briefly reported. The essential parts of the machine are a gas generator, pump and conducting pipe. The apparatus is set up and the treating pipe inserted in the grain. A measured quantity of paraformaldehyde is placed in the generator cup, and gas is generated by heating this cup from below. Pumping is begun as soon as the liquid is ignited, and a steady pressure is maintained.

In tests to determine the effect of this method of treatment on germination of wheat, it was found that the seeds in the central portion of a 120-pound sack were injured severely when the grain was allowed to stand 24 hours or more after treatment. Toward the outside of the sack, however, the grain gave a percentage germination as high as the untreated seed and higher than the standard formaldehyde dip.

With reference to the effect on the amount of stinking smut in a crop grown from smutted seeds, it was found that although the treatment may be harmful to the grain the damage may not be extensive and there is a low percentage of smut in the sample drawn from the center of the sack when left 4 days after treatment. It appears, however, that the gas treatment is decidedly inferior to the standard formaldehyde dip.

Fruit Packing Equipment, W. le G. Brereton (New South Wales Department of Agriculture (Sydney) Farmers' Bulletin 165 (1931), pp. 28, figs. 34).—Practical information on the planning, construction and use of fruit packing equipment for New South Wales conditions is presented, together with drawings of benches, trolleys, presses, and a homemade fruit-sizing machine.

Test with Wood Gas Propelled Tractor (Journal of Department of Agriculture, South Australia (Adelaide), 34 (1931), No. 11, pp. 1144-1146, fig. 1).—This test was conducted in South Australia. The data show that with wood at about $10 per ton and gasoline at about 49 cents per gallon the fuel cost of the wood gas tractor was less than one-fourth of that of the gasoline tractor. There was no noticeable difference in oil consumption, but the wood gas engine appeared to be more worn.

Bibliography of Physical Properties and Bearing Value of Soils, compiled by M. Schrero (American Society of Civil Engineers (New York) Proceedings, 57 (1931), No. 6, pp. 871-921).—A bibliography of 800 references is presented which deals with slides, slips, and subsidences; chemical and physical properties; granular material; foundations; and retaining walls. It is a contribution from the Carnegie Library of Pittsburgh.

A.S.T.M. Tentative Standards, 1930 (Philadelphia: American Society for Testing Materials, 1930, pp. 864, figs. 163).—This volume contains 155 tentative specifications, methods of test, definitions of terms and recommended practices with reference to materials of construction.

A.S.T.M. Standards, 1930.—II, Non-metallic Materials (Philadelphia: Amer. Soc. Testing Materials, 1930 pt. 2, pp. 1214, pls. 5, figs. 167).—This volume contains 251 standards, of which 248 are standards relating specifically to non-metallic materials and three are standards of a general nature applying to both metals and non-metals.

A Preliminary Report on the Artesian Water Supply of Memphis, Tennessee, F. G. Wells (U. S. Geological Survey, Water-Supply Paper 638-A (1931), pp. II + 34, pls. 2, figs. 7).—This report, prepared in cooperation with the Tennessee Division of Geology, presents a statement on the history of artesian water development in Memphis and gives data on geology, pumpage, chemical character of the water, and the like.

The Effect of Blue Stain on the Penetration and Absorption of Preservatives, W. M. Saling (American Wood-Preservers' Association (Chicago) Proceedings, 26 (1930), pp. 183, 196, fig. 1). —Studies conducted at the University of Idaho are reported. The results showed that, with moisture controlled and specific gravity comparable, the penetration and absorption of zinc chloride increases with an increase in the degree of blue stain in western yellow pine. Zinc chloride had a greater absorption than creosote for the different grades of stain, while the penetration of the two preservatives was comparable. Loblolly pine showed a greater penetration and absorption in the blued than in the unblued stock. Zinc chloride had the greater absorption for each grade of stain but about equal penetration.

Book Review

"Electricity on the Farm," published by the Committee on the Relation of Electricity to Agriculture in January 1928 as C. R. E. A. Bulletin Vol. IV, No. 1, has been revised, enlarged, brought up to date and published as C.R.E.A. Bulletin Vol. VII, No. 1 (November 1931). It summarizes in non-technical language the latest information available on more than 100 proven or experimental rural uses of electricity, covering jobs ranging from hair curling to bull taming and power loads from the insignificant demand of the electric clock to the thousands of kilowatt hours required for house heating. Paper bound, 8½ x 11 inches, 332 pages, 570 illustrations, 87 charts, 160 tables and a bibliography. Prices, one to 10 copies, $1.00 each, postage prepaid; 11 to 99 copies, 75 cents each, f.o.b. Madison, Wisconsin; 100 copies and over, 50 cents each, f.o.b. Madison, Wisconsin. Orders should be addressed to the C.R.E.A., 1120 Garland Bldg, Chicago, Ill., money orders or checks made payable to G. C. Neff, Treas., C.R.E.A.

AGRICULTURAL ENGINEERING

Established 1920

A journal devoted to the advancement of the theory and practice of engineering as applied to agriculture and of the allied arts and sciences. Published monthly by the American Society of Agricultural Engineers, under the direction of the Publications Committee.

PUBLICATIONS COMMITTEE

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The Society is not responsible for the statements and opinions contained in the papers and discussions published in this journal. They represent the views of the individuals to whom they are credited and are not binding on the Society as a whole.

Contributions of interest and value, especially on new developments in the field of agricultural engineering, are invited for publication in this journal. Its columns are open for discussions on all phases of agricultural engineering. Communications on subjects of timely interest to agricultural engineers, or comments on the contents of this journal or the activities of the Society, are also welcome.

Original articles, papers, discussions, and reports may be reprinted from this publication, provided proper credit is given.

Raymond Olney, Editor

R. A. Palmer, Associate Editor

Fallacy of Averages

AGRICULTURAL ENGINEERS believe that too much emphasis has been given to average yields, average performances, etc., in agriculture. If agriculture is to progress as it must in order to compete with other progressive branches of industry, it would seem that the time has arrived when we should discover those farmers who are getting the highest returns with the least amount of labor and set them up as examples towards which the less productive farmers should strive. This policy is being followed in educational institutions by recognizing in various ways those students whose grades put them in the upper quarter or fifth of the class. Once in a while publicity is given to a farmer who has made exceptionally good records in production, but for the most part the general trend has been to deal in averages, with the result that the farmers who find themselves equal to or close to the average are lulled into a false sense of security and satisfaction by that knowledge.

Progress can only be made by striving toward a higher goal. Recently at an annual meeting of a large utility group, attended by all the local dealers, the president of the group did not tell his men of the average business done by the dealers for the year just finished; he pointed out and complimented three or four offices that had produced the highest returns for the year, thus setting up a mark toward which the other local agents could strive.

If we are following the right principles in athletics, education, and business in honoring the more successful as an incentive towards raising the standards of the others, it would naturally follow that in agriculture we should make intensive studies of those most successful in their particular branch of agriculture. By giving these men credit for their performances and pointing out in detail how they secured their results, we encourage other farmers to raise their standards, and, in so doing, lift agriculture to a higher and more prosperous level.

L. J. SMITH[1]

* * * * *

The "Master Farmer" movement has been a step in this direction, and incidentally has shown that the best farmers are applying engineered methods and products to a remarkable extent. This suggests that agricultural engineers could be of real service in studying in more detail engineering phases of the operations of the more successful farmers and in calling them to more general attention.

[1]Professor and head of the department of agricultural engineering, State College of Washington. Mem. A.S.A.E.

Dependance on Electrification

THE extent to which America is electrified was emphasized in the public mind by the passing of Thomas Edison, unquestionably the one individual who did most to make this electrification possible.

Sentimental but uninformed individuals urged at the time that as a tribute all electric generating plants in the country cut off power for one minute at an appointed time or prearranged signal. N.E.L.A. Bulletin's anonymous "Amplifier" calls attention in the November issue to the absurdity of the proposal.

All power might be turned off at once, but the load could no more be picked up again a minute later than a freight engine can bring a heavy train to full speed instantaneously. Another mechanical difficulty would be the disrupting of the delicate synchronization by which numerous generators turn alternating current into one line, and by which separate lines are interlocked.

A general power shut down would interrupt numerous continuous processes in industry and waste millions of dollars worth of materials spoiled by the interruption. Worst of all it would cost lives unnecessarily due to failure of automatic electric safety devices, of hospital equipment, of communication and many forms of transportation,— a questionable tribute to a life of service to humanity.

After growing up with Edison's inventions for more than fifty years we cannot suddenly do without them. Power is available at the throw of a switch to serve our lordships, not because its production is an equally simple matter, but because a tremendous, intricate organization functions twenty-four hours a day to make it available, anticipating hours in advance the aggregate demand which will be created by our independent, individual actions in the changing circumstances of time, weather and current events. Any threat—mechanical, political or sentimental—to the continuous availability of electric power, is a menace to our civilization, and, on an increasing scale, to our agriculture.

Reclamation in a Federal Land Policy

IRRIGATION and the conservation of water comprise part of the development of the western part of this country in a zone 1,500 miles wide and extending from our northern to our southern boundary, which must travel along with the growth of population and industry throughout the nation as a whole. The economic development of the West is essential to national success and the best use of all our resources.

* * * * *

No activity of the federal government has brought greater private and public benefits to the nation than have come from the money spent on these government reservoirs. Unless it is continued, scores of impoverished communities will give up, thousands of farms will be abandoned. This would be a national loss as well as locally disastrous. It ought to be averted. An unhappy ending to the courage, sacrifice, and industry of thousands of worthy people who blazed the trails and began the development of irrigated agriculture would be a national calamity. The future of cities, railroads, mines and factories, as well as farms, of the arid region rests on the measures taken for the conservation of the waters of western rivers. Water is the dominating factor in all its development. Federal reclamation is meeting a national economic need and averting a crisis in the business and industrial life of the arid region.—Dr. Elwood Mead, U. S. Commissioner of Reclamation, in an address at the meeting of the Association of Land Grant Colleges and Universities, at Chicago, November 1931.

A.S.A.E. and Related Activities

Annual Meeting Program Progress

Dr. E. A. White, chairman of the A.S.A.E. Meetings Committee, has announced that the general sessions program for the annual meeting at Columbus in June is practically completed.

Acceptances already received from most of the speakers invited to address the Society as a whole have insured the carrying out of the Committee's plan. This includes, in addition to the address of welcome and the President's address, three speakers on "An Engineer's Policy for Agriculture," three other addresses on particularly interesting phases of agricultural engineering developments, and technical papers of general interest, representing contributions from the technical divisions of the Society.

The committee is not yet ready to release the names of speakers, or the details of the technical division individual and joint sessions, but is hard at work and is confident that it will have the program completed earlier than usual.

A.S.A.E. Invited to Cooperate with Rosenwald Museum

American Society of Agricultural Engineers has been invited to name representatives to advise the Rosenwald Museum of Science and Industry, in Chicago, in assembling and setting up its exhibits pertaining to agriculture. The Museum plans to demonstrate thoroughly progress in drainage and farm machinery.

Dr. Russell H. Anderson, curator of agriculture and forestry at the institution, in a letter to L. J. Fletcher, president of A.S.A.E., suggested a committee from the College Division of the Society, the members to be in a position to make occasional trips to Chicago. In his words "Such a committee should give us expert and unbiased opinions on the proper allocation of modern equipment, types of agricultural activity to be included or omitted, technical facts concerning specific exhibits, and much general advice and information."

President Fletcher, Dr. J. B. Davidson and E. W. Lehmann visited the new museum early in December. President Fletcher has asked C. E. Seitz, chairman of the College Division, to make the appointments.

California Trade Brushes Up on Agricultural Engineering

The third annual "Conference in Agricultural Engineering" for those engaged in manufacturing, selling and servicing farm machinery in California was held at University Farm, Davis, December 3 and 4. These conferences have been sponsored by the division of agricultural engineering, University of California, at the request of and in cooperation with the California Retail Hardware and Implement Association, and the Tractor and Implement Club.

H. B. Walker, professor and head of the division of agricultural engineering, was general chairman of the Conference. Other A.S.A.E. members who contributed to the program were Roy Bainer, J. P. Fairbank and B. D. Moses, also of the division of agricultural engineering, and Osgood Murdock, editor, "Implement Record."

Attention was focussed on the principles of operation and application of harvesting equipment, particularly hay making and processing machinery.

PROGRAM

Pacific Coast Section Winter Meeting
Sacramento, California

Friday, January 22, 1932
Forenoon—10:00 to 12:00
Council Chambers, City Hall

1. Call to order—O.V.P. Stout, chairman, Pacific Coast Section, ASAE
   Welcome—James Dean, city manager, Sacramento
2. Adapting the Row Crop Tractor to Sacramento Valley Conditions—L. S. Quinan, Power Farm Equipment, Sacramento
3. Standard Irrigation Structures — Max E. Cook, farmstead engineer, California Redwood Association
4. Orchard Heating—F. A. Brooks, assistant agricultural engineer, University of California

12:30—Luncheon—Elks Club
Tenth Annual Business Meeting and Election of Officers

Afternoon—2:00 to 5:00
Council Chambers, City Hall

1. Vibrations in Farm Machinery—L. M. K. Boelter, associate professor of mechanical engineering, University of California
2. The Farmer's Requirements for Transportation—J. H. Barmore, regional manager, Chevrolet Motor Co., Oakland
3. Electric Welding — B. W. Henning, Montague Pipe and Steel Co.,
4. Pump Testing and Efficiencies—R. H. Cates, power engineer, Southern California Edison Co.
5. Agriculture and the Depression—W. E. Packard, consulting agricultural engineer.

Evening—6:30

Dinner—Auditorium, Elks Club
Toastmaster—J. W. Gross, consulting reclamation engineer

1. Address—The Engineer and His Philosophies on Agricultural Development—E. A. White, chairman Meetings Committee ASAE; Director C.R.E.A.
2. Address — L. J. Fletcher, President ASAE; agricultural engineer, Caterpillar Tractor Company

International Congress Postponed

At the annual business meeting of the American Society of Agricultural Engineers held at Iowa State College in June, 1931, approval was given to a recommendation by the Council of the Society that the organization sponsor the holding of an international agricultural engineering congress at the time of the world's fair in Chicago in 1933. However, on account of the world-wide economic readjustment now going on, the Council at a meeting held in Chicago in December, on the recommendation of a number of Society members, voted to indefinitely postpone plans for sponsoring such a congress.

The annual meeting of the Society that year is to be held at Purdue University, Lafayette, Indiana. This location will make it convenient for those attending the meeting also to visit the Century of Progress Exposition at Chicago.

Agricultural Engineers Judge Contest

Wm. Kaiser, agricultural engineer, Portland Cement Association, and C. F. Miller, agricultural engineer, National Lumber Manufacturers' Association, were two of four judges who recently picked the winners of the American Farm Bureau Federation farm home improvement contest.

Two thousand dollars were awarded to 222 winners out of 14,000 entries. Prizes were based on personal achievement, exterior improvement, construction, and interior improvement from the opening of the contest March 1, 1931, to its closing on November 1. Each entry and report of activity was certified by the county agricultural agent of the farmer concerned

Cleveland Host to Refrigerating, Heating and Ventilating Engineers

For its twenty-seventh annual meeting the American Society of Refrigerating Engineers will assemble at the Hotel Cleveland, Cleveland, Ohio, January 26 to 30. It will be the first meeting of that body to be held outside of New York.

One reason for the change is a joint session with the American Society of Heating and Ventilating Engineers, on the general subject of air conditioning. Consideration will be given to "Refrigerating Machinery for Heating and

Cooling Homes," "Gas for Heating and Cooling Homes," "Unit Conditioning for Comfort and Storage Temperatures," and "Ice for Air Conditioning."

Attention will be focused, in other sessions, on refrigeration and food, commercial-domestic problems, and machinery for industrial applications.

During the same week the Second International Exposition of Heating and Ventilating will be held in the Cleveland Auditorium.

American Engineering Council

WITH ITS December 1931 issue, suspension of American Engineering Council Bulletin was announced. Reduced circumstances of some of its member bodies have made it necessary for Council to curtail expenses in this manner for at least one year.

During this period news of its activities, and those of the government of particular interest to engineers will be published in the journals of its member bodies. AGRICULTURAL ENGINEERING will keep its readers informed, in more detail than previously, of Council and government matters related to its field.

Personals of ASAE Members

Hobart Beresford is senior author of Idaho Agricultural Experiment Station Bulletin 175, entitled "Bulk Handling Grain from the Hillside Type Combine."

R. U. Blasingame, first vice-president of the American Society of Agricultural Engineers, and head of the agricultural engineering department of Pennsylvania State College, broadcast a talk from Radio Station WGY, Schenectady, on December 18, on the subject "Research Work in Rural Electrification," being one of a series of talks on farm electrification presented by that station under the auspices of the rural electrification section of the General Electric Company.

Dr. J. B. Davidson, professor of agricultural engineering, Iowa State College, and agricultural engineer, Iowa Engineering Experiment Station, is author of Bulletin 92 of the Station, entitled "Life, Service and Cost of Service of Farm Machinery."

Ronald E. Everett, formerly associated with Deere & Company, is now in charge of maintenance of mechanical equipment on Fairbanks Valley Farms, under the management of the Doane Agricultural Service of St. Louis. His post office address is Carrolton, Illinois.

Mark R. Kulp, assistant professor of agricultural engineering, University of Idaho, is author of Idaho Agricultural Experiment Station Circular No. 66, entitled "Irrigation Pumping Plants."

W. H. McPheeters, in addition to his work as extension agricultural engineer of Connecticut Agricultural College, has recently been placed in charge of all teaching work of that institution in agricultural engineering.

E. A. Silver, research agricultural engineer, Ohio State University, is author of Ohio Agricultural Experiment Station Bulletin 490, entitled "Feed Grinder Investigations," and joint author with J. H. Sitterly, rural economics department, of Bulletin 491, on "The Harvester Thresher in Ohio."

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the December issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Frank Cornell, president, Cornell Tractor Co., 10 Abbott St., Salinas, Calif.

Alvah H. Frost, technical adviser to Detroit sales division, The Vacuum Oil Company, Inc., 903 W. Grand Blvd., Detroit, Mich.

Frank H. Hamlin, advertising manager, Pepec Machine Co., Shortsville, N. Y.

Wilson T. Ide, engineer, Vacuum Oil Company, Inc., 722-18th St., Des Moines, Ia.

A. W. McCalmont, Western manager, Manufacturers Service Division, Vacuum Oil Company, Inc., 903 W. Grand Blvd., Detroit, Mich.

Celedonio V. Pereda, constructer of of agricultural machinery, "Simplex", Maquinas Agricolas. (Mail) Arroyo 1160, Buenos Aires, South America.

Russell J. Phillips, district sales manager, Dairy Equipment Department, International Harvester Co., 105 Fulton Ave., Cincinnati, O.

Transfer of Grade

Earl D. Anderson, research fellow in agricultural engineering, Iowa State College, Ames, Ia. (Student to Junior)

Darrell B. Lucas, associate professor, School of Commerce, New York University. (Mail) 412 Valley Road, Upper Montclair, N. J. (Associate to Affiliate)

Joseph W. Simons, lumber utilization designer, Long Bell Lumber Sales Corp., 913 R. A. Long Building, Kansas City, Mo. (Student to Junior)

Frank J. Zink, associate professor of agricultural engineering, Kansas State Agricultural College, Manhattan. (Associate to Member)

New ASAE Members

R. E. Backstrom, insulation specialist, National Committee on Wood Utilization, Department of Commerce, Washington, D. C. (Mail) 2707 Adams Mill Road, Apt. 200.

C. T. Cheney, instructor, department of agricultural engineering, Iowa State College, Ames, Iowa. (Mail) 1013 Ninth St.

L. J. Denmire, R.F.D. 1, Montrose, Ia.

J. H. Lane, manager, eastern sales, Long-Bell Lumber Sales Corporation, 913 R. A. Long Bldg., Kansas City, Mo.

M. W. Ross, branch manger, International Harvester Co., Des Moines, Ia.

O. J. Trenary, instructor, department of agricultural engineering, University of Nebraska, Lincoln, Nebr. (Mail) 240 N. 16th St.

C. N. Turner, extension agricultural engineer, University of Maine, Orono, Maine. (Mail) 22 Myrtle St.

ASAE Meetings

Pacific Coast Section—at Sacramento, California, Friday, January 22, 1932.

Southern Section — at Birmingham, Alabama, February 3, 4 and 5, 1932.

Twenty-Sixth Annual Meeting — at Columbus, Ohio, Monday, June 20, to Thursday, June 23, 1932, inclusive.

EMPLOYMENT BULLETIN

An employment service is conducted by the American Society of Agricultural Engineers for the special benefit of its members. Only Society members in good standing are privileged to insert notices in the "Men Available" section of this bulletin, and to apply for positions advertised in the "Positions Open" section. Non-members as well as members, seeking men to fill positions, for which members of the Society would be logical candidates, are privileged to insert notices in the "Positions Open" section and to be referred to persons listed in the "Men Available" section. Notices in both the "Men Available" and "Positions Open" sections will be inserted for one month only and will thereafter be discontinued, unless additional insertions are requested. Copy for notices must be received at the headquarters of the Society not later than the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. There is no charge for this service.

Men Available

AGRICULTURAL ENGINEER with bachelor's degree in agricultural engineering from Kansas State College, master's degree from Iowa State College, 1½ years' experience with utility company, and farming experience, desires position teaching in a college or in rural service work with a utility company. Age 27. Married. MA-207.

RURAL SERVICE ENGINEER, graduate of state college and university in electrical engineering and agricultural engineering respectively, with two years' research work in rural electrification and one and one-half years' experience in large power company, is interested in new connection with power or electrical equipment concern. Would consider college or extension work. Desires location in a far western state. Age 25. Married. MA-208.